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HISTORY
of
LANGLEY FIELD

LANGLEY FIELD, VIRGINIA

INCEPTION TO 1 MARCH 1935

FIRST PERIOD

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10.11 Fort Monroe—12-4-44—60

FIRST AIR FORCE
Mitchel Field, N.Y.

HISTORICAL SECTION

MONITOR'S REPORT

Name of Unit: AAB, Langley Field, Va.

Installment: Inception to 1 Mar 35

Disposition: Forwarded

Monitor's Report:

1. Narrative section:

Excellent. Concentrates skillfully on topics of military significance from the early period.

2. Appendix:

Excellent.

3. Format:

Superior.

L.L.L.

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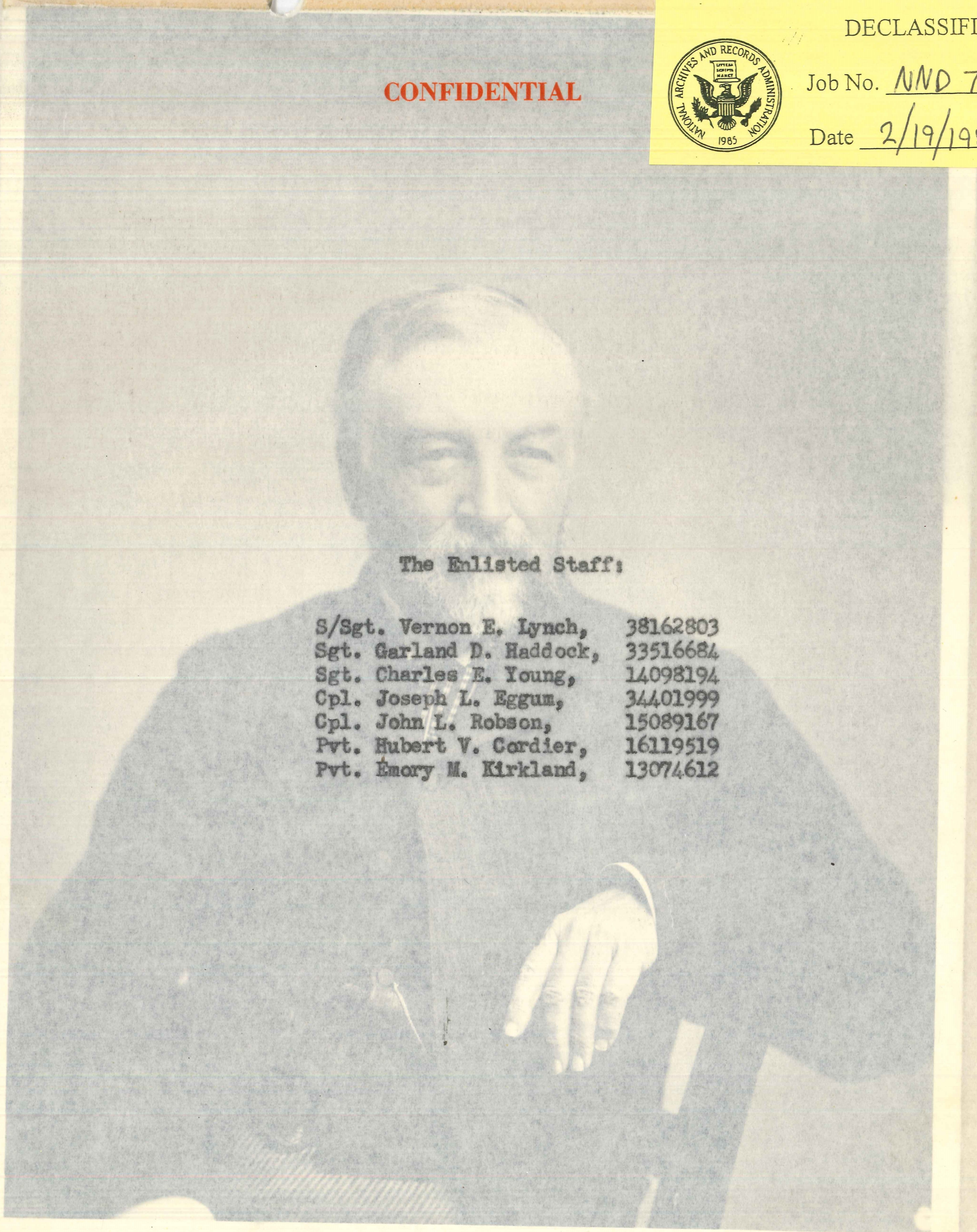
HISTORY OF LANGLEY FIELD

LANGLEY FIELD, VIRGINIA

Inception to 1 March 1935

First Period

Dorothy C. Pyle
DOROTHY C. PYLE
2d Lt., Air Corps
Asst. Historical Officer,
First Air Force



The Enlisted Staff:

S/Sgt. Vernon E. Lynch,	38162803
Sgt. Garland D. Haddock,	33516684
Sgt. Charles E. Young,	14098194
Cpl. Joseph L. Eggum,	34401999
Cpl. John L. Robson,	15089167
Pvt. Hubert V. Cordier,	16119519
Pvt. Emory M. Kirkland,	13074612

SAMUEL P. LANGLEY (1834 - 1906)

Langley Field is his memorial, and the airplane is his dream come true.

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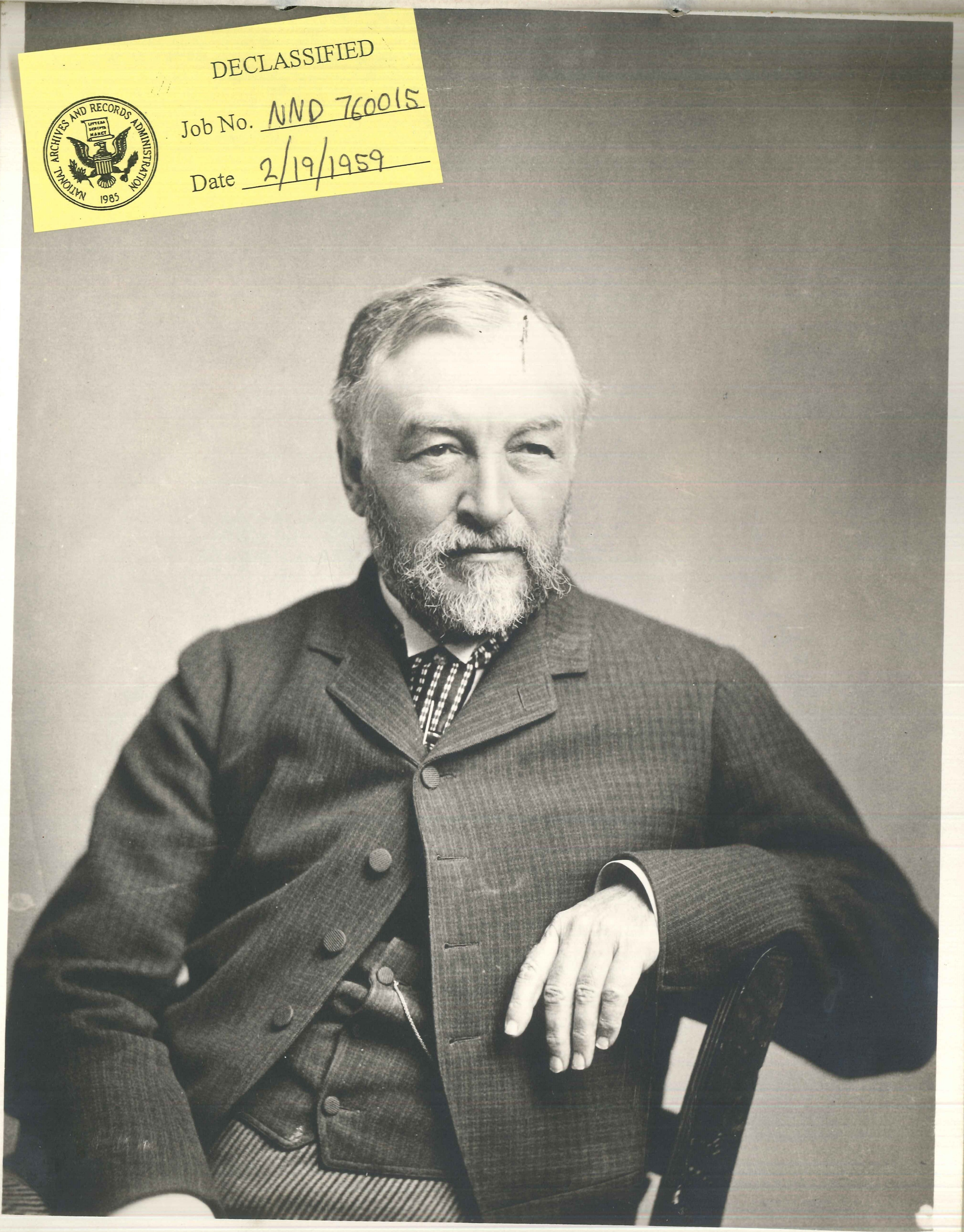

SAMUEL P. LANGLEY (1834 - 1906)

Langley Field is his memorial, and the airplane is his dream come true.

PREFACE

This history deserves to be colorful, for momentous happenings have transpired at Langley Field; it ought to be lengthy, for the field is relatively old among air fields. The assignment called for a brief history covering approximately twenty-nine years, to be submitted in three installments, as follows: first, inception to 28 February 1935, when the General Headquarters of the Air Corps moved to the field; second, from 1 March 1935 to 6 December 1941, to continue the story until the date of the Japanese attack on Pearl Harbor; and third, from 7 December 1941 until 15 September 1944, when Langley Field passed from the jurisdiction of the First Air Force to become a station of the AAF Technical Training Command.

For this first installment of the series, the authors tried to record both routine activities and some outstanding events, by means of documentary photographs, maps, interviews, letters, clippings, deeds, and such manuscripts as were available.

There were, of course, some limitations on the authors. For example, many valuable records of the field were damaged by a flood in 1933, and were burned by authority of the Adjutant General in 1943. As usual, there was a time limit on research and writing.

There was time, however, for profitable trips to nearby county courthouses in Hampton, Denbigh, and Yorktown, Virginia; to Mulberry Island, site of Fort Eustis; and to the offices of L. M. von Schilling, Gerald Chambers, and H. H. Holt, prominent Hampton business men familiar with the early history of Langley Field.

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Because it contains a discussion of the construction and layout of the field, and photographs thereof, along with much vital material about the work of the Langley Memorial Aeronautical Laboratory, it has been considered advisable to classify this history as confidential.

The authors gratefully acknowledge assistance from many, and particularly from the following: Lieutenants R. W. Hirst and W. D. Kelley, of the base photographic laboratory; Col. C. F. Greene, liaison officer for the NACA; Mr. Starr Truscott, chief of the hydrodynamics department of the Langley Memorial Aeronautics Laboratory; Mrs. E. R. Gilman, NACA librarian on the field; Mr. Norman E. Noll, history-conscious employee on the hangar line; the base engineer and his assistants E. E. McCaffrey and Harry E. Livers; Mrs. H. S. Reams, secretary to the base public relations officer; Miss Julia Lybrook, office of the base adjutant; Mr. C. H. Gordon of the base civilian personnel office; Staff Sergeant George E. Hodge, a former researcher; Mrs. Patricia Nash, typist; and Lieutenant Marcus W. Floyd, base historical officer, who gave generously from material and personnel resources at his command.

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CHAPTER 1

BACKGROUND AND PHYSICAL PLANT

Samuel Pierpont Langley, in the lifetime which he devoted to demonstrating by his experimental work the practicability of mechanical flight, succeeded with small models of his "aerodrome", as he called his flying machine, in 1896. He retired from experimentation during that year, leaving to others the work of building a full-scale airplane capable of carrying men aloft. The Spanish-American War in 1898 stirred President McKinley's interest in such a project, and through the President's intercession two allotments of twenty-five thousand dollars each were made by the War Department to the Smithsonian Institution, of which Langley was secretary, for the building of a full-scale "aerodrome." Langley, an astronomer and physicist, made two unsuccessful attempts in 1903 to launch his enlarged "aerodrome" from a catapult mounted on a houseboat in the Potomac River. The wreckage of the flying machine was put away in the Smithsonian Institution, and Langley himself died 27 February 1906, having been the butt of much ridicule in the nation's press.

Dr. Charles Doolittle Walcott succeeded Langley as secretary of the Smithsonian Institution, and in 1912 he secured permission from his board of regents to reopen the Langley Workshop in the Smithsonian Institution. The workshop was to be operated as the Langley Aerodynamical Laboratory, the work to be directed by an Advisory Committee for Aeronautics, which would be created by the Smithsonian Institution.[1] The proposed advisory

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(1) 1. Authenticated interview, Mr. John F. Victory, Secretary, NACA, 23 Aug 44.

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committee was established, but its work was short-lived, due to a ruling by the Comptroller of the United States Treasury, who held that Government personnel and supplies could not be used in the prosecution of the committee's work. Thereupon Dr. Walcott sought enactment of legislation to create a National Advisory Committee for Aeronautics, but met with only meager interest in the Congress of the United States until the first World War broke out in the summer of 1914. At first President Wilson opposed the project on grounds of strict adherence to neutrality, but eventually legislation was passed which Wilson approved on 3 March 1915, establishing by law the National Advisory Committee for Aeronautics.[1]

Acquisition of Site

The concept of Langley Field originated at meetings of the NACA during the summer of 1916, when it was agreed that there should be developed a joint experimental air field and proving ground for aircraft, to be used by the Army, the Navy, and the NACA. The Signal Corps, as the Army agency concerned with aircraft (through its Aviation Section), agreed to finance the purchase of lands and appointed a board of officers to inspect sites.[2] The Navy did likewise. According to the best information available to the historian,

> "Each group traveled separately and as civilians, posing as hunters or fishermen. The NACA appointed a committee of three to consider the sites recommended

---

(1) 1. Authenticated interview, Mr. John F. Victory, Secretary, NACA, 23 Aug 44.

(2) 2. (No file number), and two Incls. Lt. Col. George O. Squier, Signal Corps, to: the Adjutant General, 4 Dec 16, subj: "Acquisition of Land for Aviation Purposes."

> by the Army and Navy groups, respectively. The choice narrowed down to the sites now known as Aberdeen, Maryland, and Langley Field, Virginia, and the naval point of view prevailed in the selection of Langley Field, because it was contiguous to salt water and deep water."[1]

The Government's site committee[2] consisted of Lieutenant Colonel George O. Squier of the Signal Corps, who was the chairman, Captains Clark and T. D. Milling; and Captain R. C. Marshall of the Quartermaster Corps.

Publication of the news of the projected Aeronautical Experimental Station in the late summer of 1916 caused civic-minded citizens of Elizabeth City County, Virginia, to form a committee for the purpose of attracting the proposed installation to their locality. The committee consisted of Harry H. Holt, H. R. Booker, and Nelson S. Groome, all of whom had close political ties locally and in Washington. The lands which they were empowered to place at the Government's disposal were located on the "Peninsula" of Virginia, and met substantially all the basic requirements: location near an established Army installation (Fort Monroe); good facilities for over-water flying; and suitability for the landing and taking off of land-based aircraft.

One suggestion of the local committee, that the bottom of Mill Creek be filled in and used for the necessary aviation experimental station, was rejected by the Government, which wanted 1,500 to 2,000 acres of land

---

(1) 1. Authenticated interview, Mr. John F. Victory, Secretary, NACA, 23 Aug 44.

2. Norman E. Noll, in The Virginian Pilot, Norfolk, Va., 31 Dec 39. The board was appointed by S.O. 216, War Dept., Wash., D.C., 1916. Capt. Marshall later became Brig. Gen., according to L. M. von Schilling, Chairman, Board of Directors, Merchants National Bank, Hampton, Va., interviewed 16 Nov 44.

with a diagonal length of three miles, in order that all types of aircraft might land in all directions.[1]

After Messrs. Holt, Groome, and Booker had procured options on the land they wished to sell to the Government for $290,000, at approximately $175 per acre,[2] they presented their offer to Captain T. D. Milling, the recorder for the site board, on 17 November 1916. Before any action was taken on the offer, a subsequent proposal[3] was made on 22 November 1916, retracting part of the first offer to clear certain areas of shrubs and trees. Most of the provisions of the original offer were retained; the committee agreed to install an electric railway line, provide electric current and a water supply,[4] and secure necessary easements from farmers in the vicinity who agreed to permit planes to fly over their lands.[5] The local committee also agreed to construct a railroad trestle and another bridge across Back River, and build a dirt road connecting the site with

---

1. Norman E. Noll, in The Virginian Pilot, Norfolk, Va., 31 Dec 39.

2. This was not considered a high cost, in view of the construction promised and the fact that the tract contained a few improvements, such as the colonial-type home that later was used by the commanding officer of the field.

(3) 3. (No file number) Two letters, H.R.Booker, Nelson S. Groome, H.H.Holt, Hampton, Va., to: Capt. T.D.Milling, Recording Officer of Board of Officers, War Dept., Wash., D.C., 17 Nov 16 and 22 Nov 16.

4. Beginning in 1930, the Government began to acquire parcels of land for a water supply at Bethel, Va., in the area where the first battle of the War between the States was fought.

(4) 5. A typical easement: (No file number) Paul Tabb, Hampton, Va., to: Messrs. H.R.Booker, N.S.Groome, and H.H.Holt, Hampton, Va., 17 Nov 16.

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the nearest county road. The deed[1] to the original tract was dated 30 December 1916, and the purchase price of $290,000 was paid in cash.

The site chosen was approximately 1,650 acres of level land, lying almost due north of Hampton, Virginia, about four miles distant in Elizabeth City County. The tract was composed of the original land grant estates known as Sherwood,[2] Lamington, Pools and Moorefield, as well as a small portion of Canebrake Farm. It was bordered on the south by the southwest branch of Back River, on the east by Back River, on the north by Tabbs Creek, and on the west by Shellbank Farm, which belonged to the Hampton Normal and Agricultural Institute, and the Collier Estates.[3] The average elevation of the original land was six feet above mean sea level. There was a sparse growth of trees and underbrush, which had to be removed. The soil consisted primarily of light sandy loam to a depth of five to 25 feet below ground level, with a stratum of blue clay of varying depth beneath. The bearing capacity of the original soil averaged 2,000 pounds per square foot. Ground water level was three to four feet below the

---

(5) [1] Deed, H.R.Booker, et al, to the United States of America, 30 Dec 16 (verified 24 Feb 17), transferring 1,650 acres (Langley Field) for $290,000. Recorded in Deed Book 60, p. 444 of the public records of Elizabeth City County, Va.

[2] Directly across from the Officers' Club, near the south end of the bridge leading to the field, is an old cemetery dating back to the era of Capt. John Smith and the 17th century. Inscribed on a bronze marker set in granite in this old burial place is the following: "Burial ground of Sherwood, an estate of 750 acres, a grant from the English Crown to the Purefay family in the early 17th Century, heired by their kin, the Marshall and Booker families."

(6) [3] Map of Langley Field, compiled by tracings from maps of Elizabeth City County, Va.; compiled by J.L.B.Buck 1917 and L.C.Lyman 1908; and map dated Feb 1917 by Girard Chambers.

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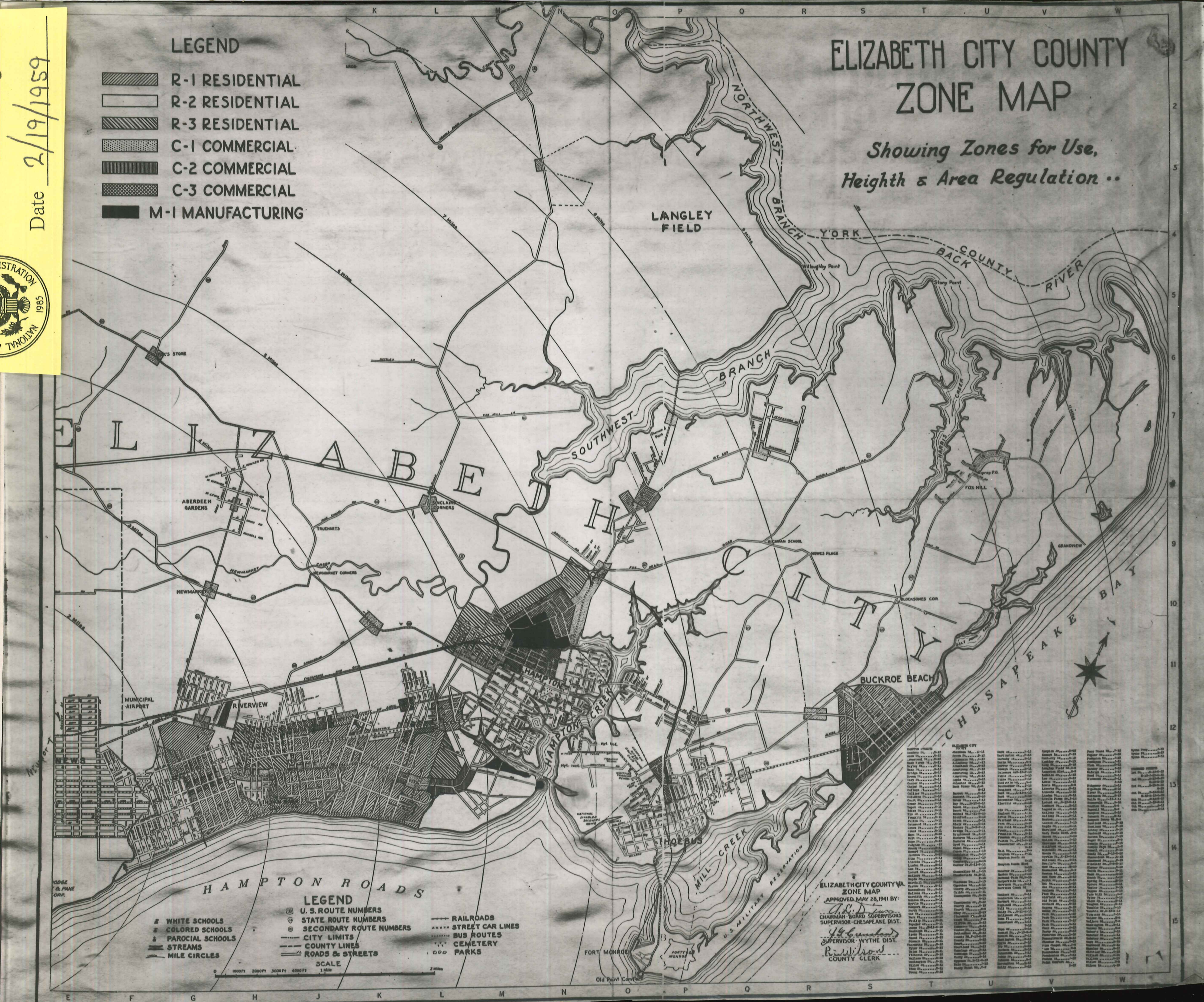
ELIZABETH CITY COUNTY
ZONE MAP
Showing Zones for Use, Heighth & Area Regulation..
LEGEND
R-1 RESIDENTIAL
R-2 RESIDENTIAL
R-3 RESIDENTIAL
C-1 COMMERCIAL
C-2 COMMERCIAL
C-3 COMMERCIAL
M-1 MANUFACTURING
LANGLEY FIELD
NORTHWEST BRANCH
YORK COUNTY
BACK RIVER
SOUTHWEST BRANCH
ELIZABETH CITY
ABERDEEN GARDENS
SINCLAIR CORNERS
NEWMARKET
NEWMARKET CORNERS
FOX HILL
GRANDVIEW
BUCKROE BEACH
CHESAPEAKE BAY
HAMPTON
HAMPTON CREEK
MUNICIPAL AIRPORT
RIVERVIEW
NEWS
PHOEBUS
MILL CREEK
U. S. MILITARY RESERVATION
FORT MONROE
Old Point Comfort
HAMPTON ROADS
LEGEND
U. S. ROUTE NUMBERS
STATE ROUTE NUMBERS
SECONDARY ROUTE NUMBERS
CITY LIMITS
COUNTY LINES
ROADS & STREETS
WHITE SCHOOLS
COLORED SCHOOLS
PAROCIAL SCHOOLS
STREAMS
MILE CIRCLES
RAILROADS
STREET CAR LINES
BUS ROUTES
CEMETERY
PARKS
SCALE
0
1000 Ft
2000 Ft
3000 Ft
4000 Ft
1 Mile
2 Miles

ELIZABETH CITY COUNTY VA.
ZONE MAP
APPROVED MAY 28, 1941 BY:
A. L. D[illegible]
CHAIRMAN · BOARD SUPERVISORS
SUPERVISOR · CHESAPEAKE DIST.
J. G. Crenshaw
SUPERVISOR · WYTHE DIST.
R. L. Wilson
COUNTY CLERK

average ground elevation.[1]

The location was one readily accessible to officials from Washington, and also was reasonably convenient to the principal manufacturing centers of the East. Climatic conditions were temperate, and although the area was subject to heavy rainfall and much bad flying weather, similar to England's, work was adjudged possible to year around. Undoubtedly a factor in the selection of a site was the central location with regard to the entire eastern seaboard of the United States.[2] Moreover, the place chosen was sufficiently remote from the entrance to Chesapeake Bay to insure a measure of immunity from hostile operations of enemies approaching by sea.[3] Perhaps most important of all, the location afforded facilities for the use of aircraft on both land and water under nearly all conditions likely to be met in combat.

Evaluation of the original site. There were some distinct disadvantages inherent in the site; for example, the land from Richmond, Virginia, to Langley Field, as the site of the Aeronautical Experimental Station came to be called,[1] is a vast field of glacial scour, composed of loam, sand, gravel, and muck deposited between striations of rock. The presence of these diverse types of soil was later given as the cause of tremors throughout the vicinity, from Old Point Comfort to Yorktown, when planes from Langley Field engaged in bombing practice.[2] The same conditions made the first construction difficult, in that many permanent buildings had to be erected on foundations of piling. Especially was this true of ground adjacent to the air field proper, for into this area jutted two large tidal inlets or marshes, known as "Lamington" and "Colored Camp" sloughs.

---

[1] During the winter rainy season these figures for ground water level were reduced by at least 50 per cent.

(3) [2] (No file number) Two letters H.R.Booker, Nelson S. Groome, H.H.Holt, Hampton, Va., to: Capt. T.T. [D?]Milling, Recording Officer of Board of Officers, War Dept., Wash., D.C., 17 Nov 16 and 22 Nov 16.

[3] Second Annual Report of the National Advisory Committee for Aeronautics for the Fiscal year ended 30 June 1916, Government Printing Office, Wash., D.C., 1917.

In preparing the first landing field, the forest and shrubs were first removed, the terrain was leveled and soil was pumped in to fill the marshland. Then a system of subsoil tile drainage was installed throughout the field, including the area of the hydraulic fills. These last were the two aforementioned sloughs and the Willoughby Point bogland. The work was done by dredges of the Atlantic, Gulf, and Pacific Company, which, under a sub-leasing agreement with the J.G.White Engineering Corporation, contractors for the entire field, was engaged in providing channels through the branches of Back River for boats to reach the boat house and wharves of the new installation. Under this arrangement, the material dredged was

---

1. The experimental station was named the Langley Memorial Aeronautical Laboratory. This remained a major activity, and was the parent laboratory for two other NACA installations at Moffett Field, Calif., and Cleveland, Ohio.

2. Information secured by unrecorded interview between Gerald Chambers, Jr., Elizabeth City County, Va., surveyor, and Lt. Dorothy C. Pyle, A.C., Asst. Historical Officer, F.A.F., 20 Nov 44.

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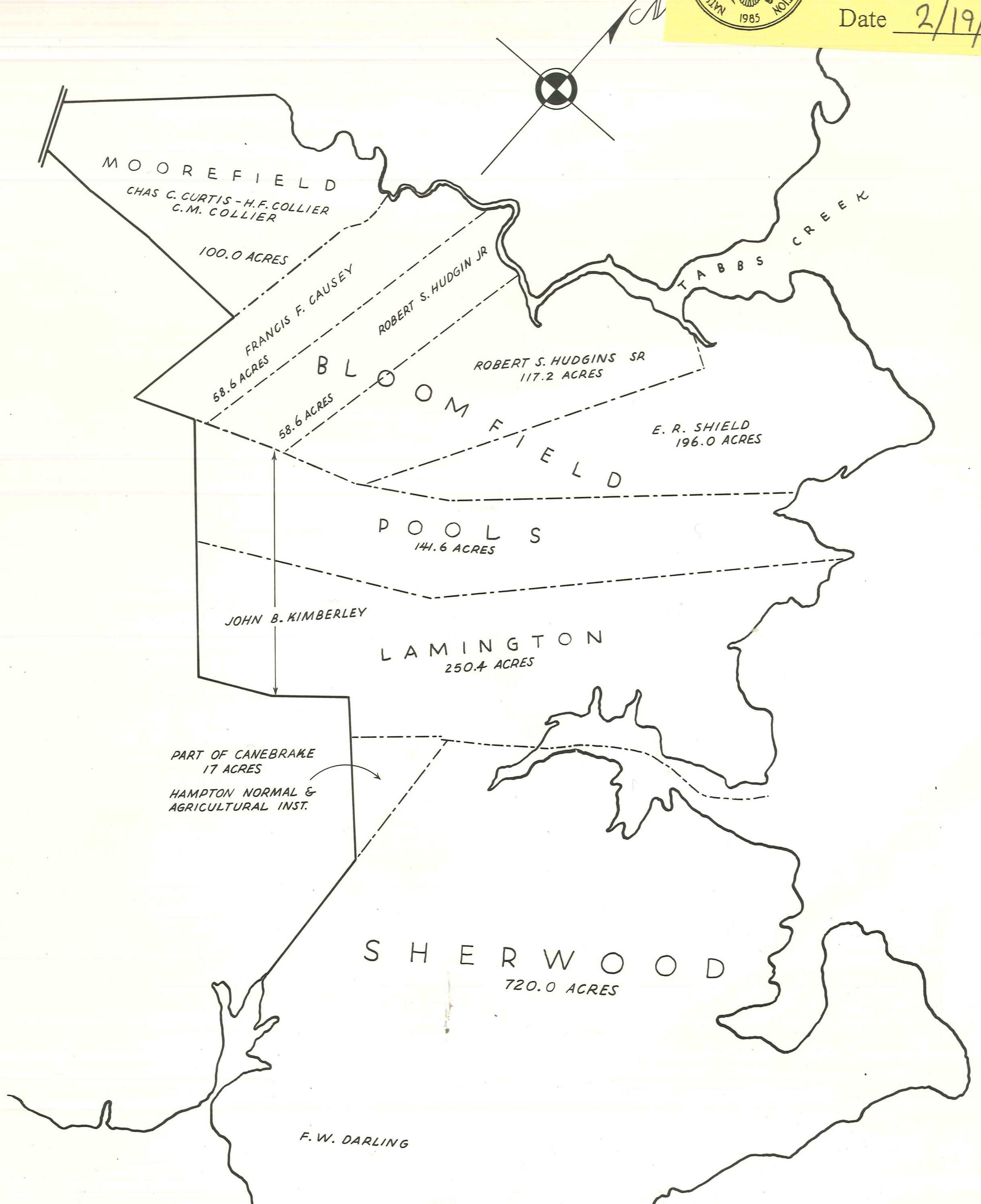
Map of Langley Field, Virginia

Showing Original Tracts, 1916


N
MOOREFIELD
CHAS C. CURTIS - H.F. COLLIER
C.M. COLLIER
100.0 ACRES
TABBS CREEK
FRANCIS F. CAUSEY
58.6 ACRES
ROBERT S. HUDGIN JR
58.6 ACRES
BLOOMFIELD
ROBERT S. HUDGINS SR
117.2 ACRES
E. R. SHIELD
196.0 ACRES
POOLS
141.6 ACRES
JOHN B. KIMBERLEY
LAMINGTON
250.4 ACRES
PART OF CANEBRAKE
17 ACRES
HAMPTON NORMAL &
AGRICULTURAL INST.
SHERWOOD
720.0 ACRES
F.W. DARLING

MAP COMPILED FROM COPY OF PLAT MADE BY GERALD CHAMBERS DATED 30 DEC 1916 WHICH ACCOMPANIED DEED ~ TOTAL ACREAGE 1659.4

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PHOTO SECTION
LANGLEY FIELD,
VIRGINIA

used as fill in the areas designated. By 15 August 1918, when the dredging program was discontinued upon orders from Washington, over 2,357,000 cubic yards of hydraulic fill had been so deposited at a cost of $395,587.[1]

The citizen's committee made an arrangement with the Newport News and Hampton Railway, Gas, and Electric Company to supply the railway they had promised.[2]

The system of sub-soil drainage -- farm tile installed in herringbone pattern -- was considered 100 per cent efficient when it was first laid, but in the area of the flying field, especially, this percentage had declined to approximately 60 per cent by 1944, due to neglected maintenance occasioned by a lack of necessary funds in the years prior to 1937. Other factors contributing to the problem of adequate drainage on the flying field included the influence of abnormally high tides on the underground water table, the impervious nature of the blue clay strata, and excessive rainfall concentrated in the winter rainy season.

Construction

Perhaps because of the faults inherent in a cost-plus contract, and certainly because the exigencies of the first World War made construction seem too slow, Langley Field was described by Colonel Squier as the "bottleneck of the aircraft program" during the summer and fall of 1917. The

---

1. Figures drawn from private files of John Werth, deceased, once post engineer and superintendent of construction, Langley Field, Va. Filed in office of post engineer, Langley Field, Va.

(7) 2. (No file number), J. N. Shannahan, Pres., Newport News and Hampton Railway, Gas, and Electric Co., Hampton, Va., to Messrs. Booker, Holt, and Groome, 8 Nov 16.

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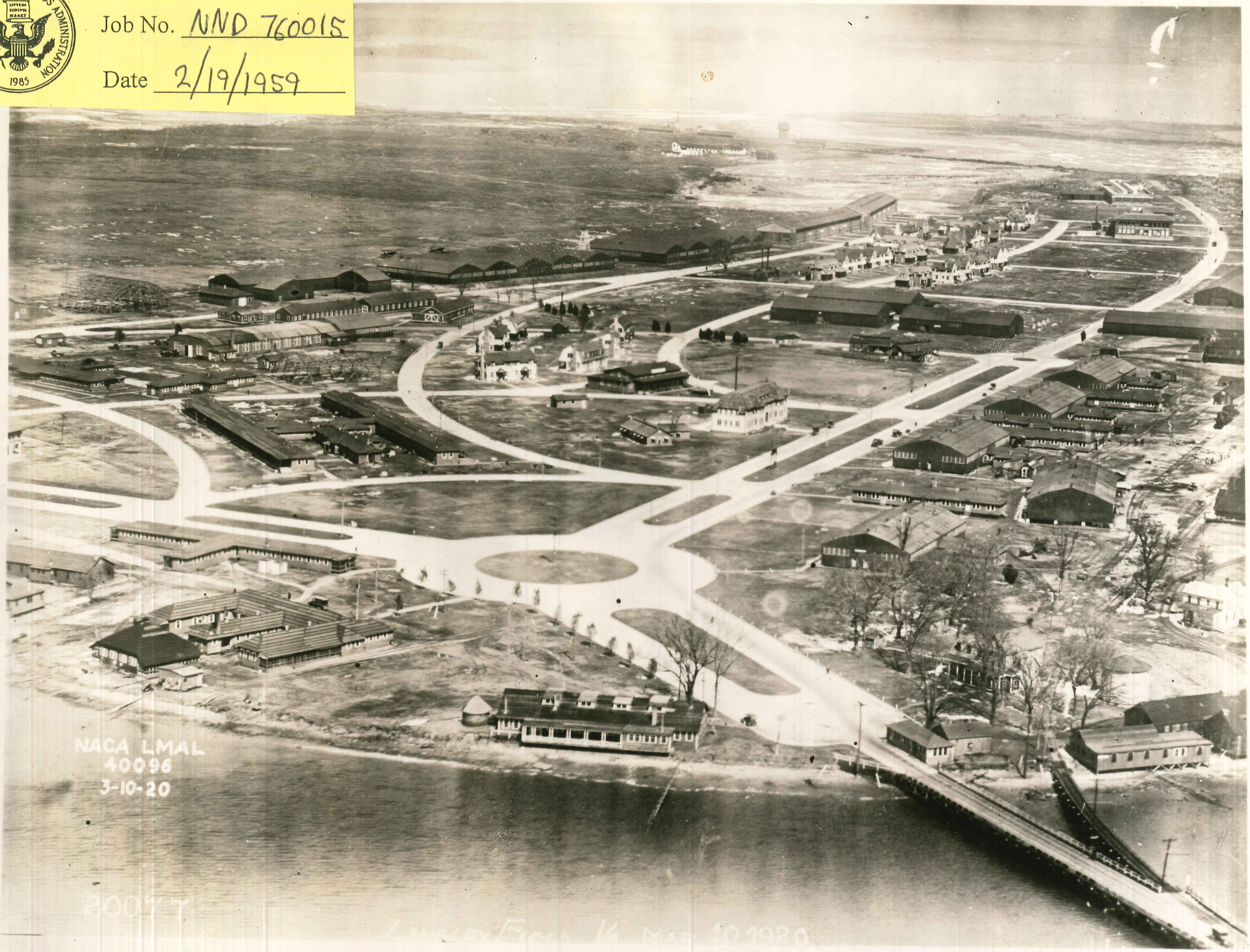
NACA LMAL
40096
3-10-20
20077
Langley Field Va Mar 10 1920

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS
LANGLEY MEMORIAL AERONAUTICAL LABORATORY - LANGLEY FIELD, VA.

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AAF TRAINING COMMAND
US ARMY AIR FORCES
BASE PHOTO SECTION
LANGLEY FIELD
VIRGINIA
CREDIT LINE MUST BE READ

J. G. White Corporation undertook to build all the permanent buildings, including the research laboratory for the NACA. At first only one such laboratory was required; later, this building became the administration building for the NACA.

Work at Langley Field progressed so slowly that Colonel Edward A. Deeds, Chief of the Bureau of Equipment of the Signal Corps, secured authority to establish a temporary experimental field at Dayton, Ohio. This station, called McCook Field, was the forerunner of Wright Field. It was hastily constructed and was in use before any of the permanent buildings at Langley Field were completed.

The Navy, in the meantime, likewise tired of waiting and secured experimental bases elsewhere.

Mr. John Werth, engineer and superintendent of construction at Langley Field during much of the early period, attributed the delays to too many supervisors, changes in plans on the part of the Government, and the weakness of the cost-plus contract. For example, he wrote

> "In justice to the present Contractors, the fact must not be overlooked that when they first took the contract, it was understood that a small force of five hundred or more men would handle the work. About the first of August [1917] orders were given to increase this force and rush the construction of such buildings as plans had been gotten out for, regardless of whether these were the buildings that were first needed, and an organization was formed to carry on work on the entire field simultaneously. During the middle of October orders were again changed, causing operations to be directed toward other portions of the work which it is now deemed more important to construct first. ....
>
> "The foregoing recital of the changes in plan, which caused the Contractor to enlarge his first organization and equipment

> and then later to direct his forces toward a new building plan, finds him at present without a definite building programme and without a schedule showing when he expects to complete his operations. I criticize the Contractor for not furnishing this information at once.
>
> * * * * * * * * * * *
>
> "Now, notwithstanding the magnificent outlay in equipment and quarters and an average supply of labor -- in other words the best of conditions -- why is it we are not getting results?
>
> "In the writer's opinion and in plain English, there are too many bosses, and too much division of responsibility. As an illustration, let us consider just one operation (which will serve as a fair example of the others) that of the streets and curbs. On this work which is spread over an area of one hundred by twelve or fifteen hundred feet, there are three general foremen, eight gang foremen, one Field party giving lines and grades and one engineer in the office who I have been told devotes his entire time to streets and curbs. It requires under present management this "over head" to supervise the efforts of seventy seven -77- common laborers, four -4- cement finishers, two -2- enginemen, and fifteen -15- teams on this work.
>
> "I venture to assert that were this a "unit price" contract instead of "cost plus" that the "over head" would be cut to something approximating the following: - one general foreman, five gang foremen and a portion of one Field party's time, and that the amount of work accomplished would be greater."[1]

Despite initial delays in construction, rapid expansion interspersed with years of relative inactivity characterized Langley Field's growth. There was the original period of construction, largely temporary, from 1917 to 1922; a permanent building and modernization program ensued from 1930 to 1935. The NACA was allotted about six acres for buildings on the original tract. This area, together with most of the landing field proper and the

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(8) 1. (No file number) Mr. John Werth, Supt. of Construction, Langley Field, Va., to: Major C. T. Waring, Construction Division, Signal Corps, U.S.A., Langley Field, Va., 6 Dec 17.

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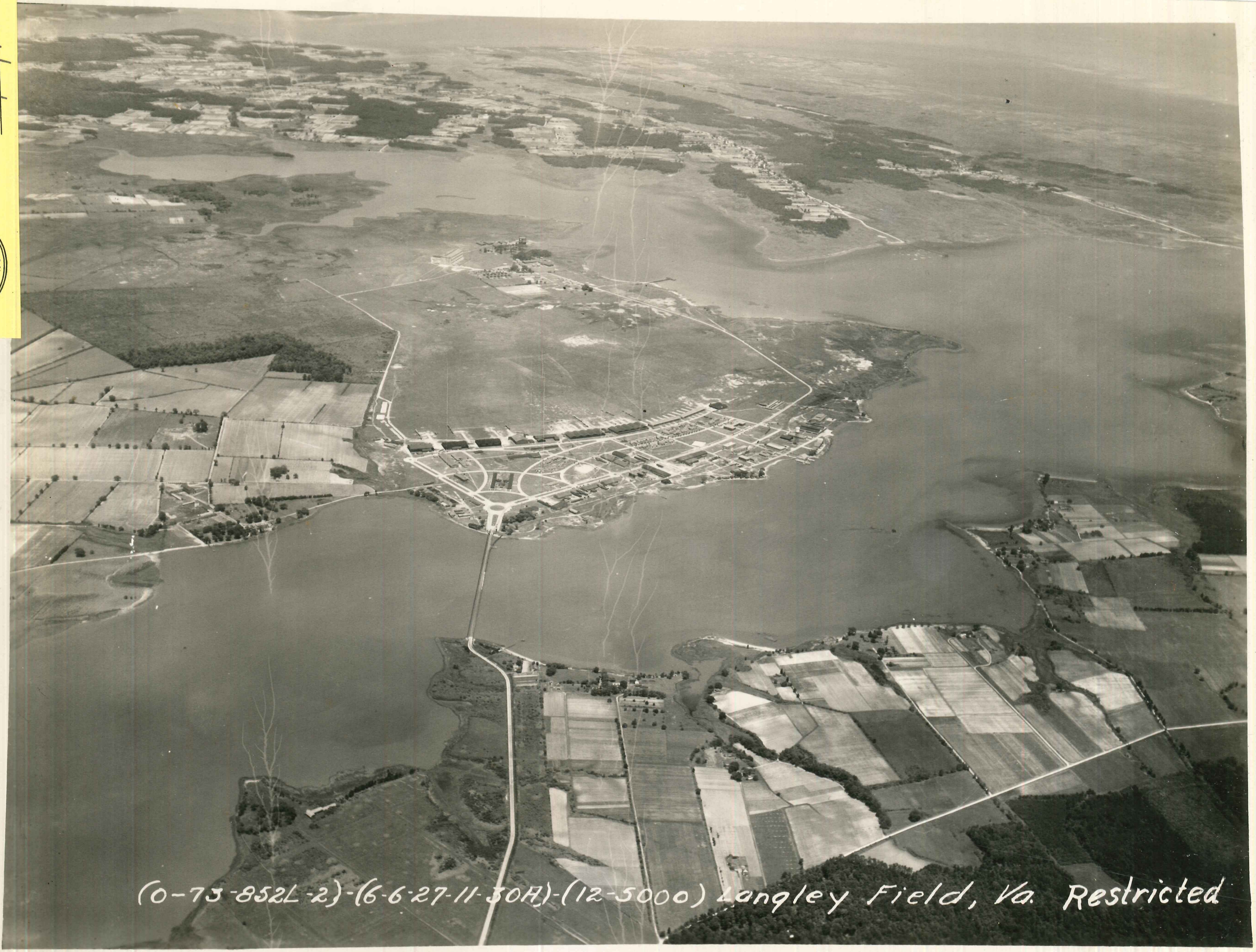

(0-73-852L-2)-(6-6-27-11-30A)-(12-5000) Langley Field, Va. Restricted

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Army's structures, was located on what had been the Sherwood Farm. All runways on the field were grassy and unpaved until 1931.

Before 1930, Langley Field personnel and equipment, apart from the NACA, were housed principally in temporary buildings. Permanent structures consisted of officers' quarters, the administration building, boat house, balloon hangar, two brick airplane hangars (constructed in 1919), and a few miscellaneous small buildings. The barracks were semi-temporary, constructed of sheet iron and steel. Noncommissioned officers' quarters were wooden, of the hastily-built type, and they deteriorated rapidly. Many commissioned officers and noncommissioned officers of the higher grades were on commutation and lived in the adjoining communities.

Although its decision to award a cost-plus contract[1] for the original structures on Langley Field was much criticized, the Army departed from the then-customary procedure and employed Mr. Albert Kahn, a prominent civilian architect from Detroit, Michigan, to lay out the proposed joint experimental field and proving ground.[2]

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[1] This was a cost-plus-ten-per-cent contract, according to Mr. Harry R. Livers, veteran administrative assistant in the office of the post engineer, Langley Field, Va., interviewed 1 Dec 44.

[2] Much of the information on the early construction period has been derived from an envelope containing so-called irreplaceable records, filed in the office of the post engineer, Langley Field, Va. These are by no means complete, but contain almost all the record available on engineering, ownership of property, and related data for the years 1917 to 1919. The papers were the private files of John Werth, deceased, once engineer and superintendent of construction at Langley Field.

Included in the papers of John Werth is a small booklet entitled "Specification No. 796 for an Aeronautical Experimental Station for the United States Signal Corps at Langley Field,

10.11 Fort Monroe—10-23-44—10,000

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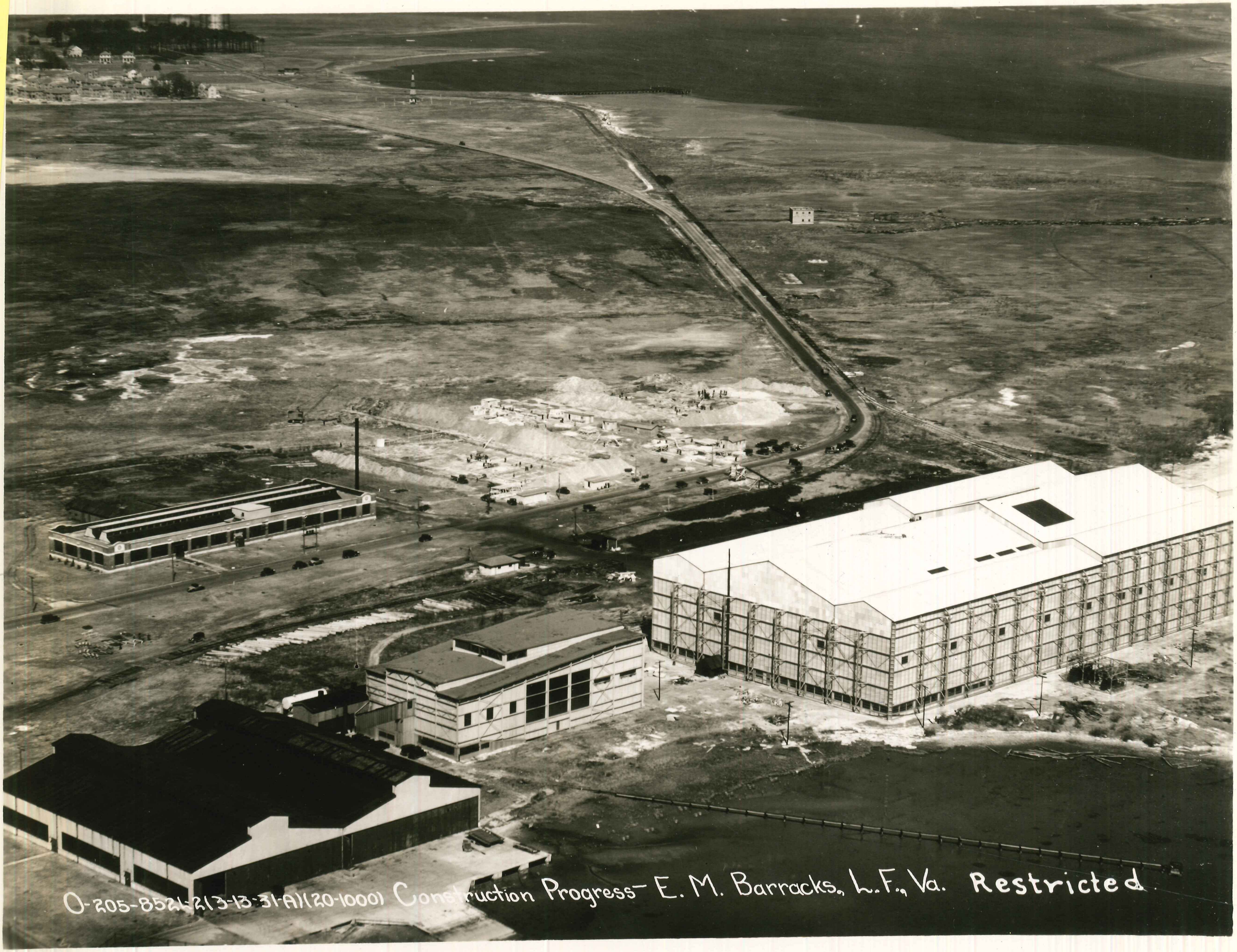

O-205-8521-2(3-13-31-A)(20-1000) Construction Progress- E. M. Barracks, L. F., Va. **Restricted**

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Complete and itemized cost data on the early period of construction was not filed, or at any rate was not available in 1944. Some papers were destroyed as late as 1943.[1] The most detailed source material was a recapitulation of costs for the period June 1917 to March 1919, prepared by or for John Werth.[2] The cost figures indicate an over-all expenditure of $7,307,854, but the extent of completion of the building program cannot be determined from figures available, so one can only guess at the total cost of the buildings mentioned. The cost summary does reveal, however, that all the major installations built during the early period, except the airship hangar and noncommissioned officers' quarters, were included for

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near Hampton, Virginia, in conformity with accompanying drawings prepared by: Albert Kahn, Architect, and Ernest Wilby, Associate, Marquette Building, Detroit." The group of buildings to be constructed as listed therein is as follows: "Laboratory Building; Engine Test Building; Power Plant; Airplane Hangars; Seaplane Hangars; Storehouses (Technical, Rough Stock); Airplane Storehouse; Storehouse, Freight; Lumber Storehouse; Barracks; Sewage Disposal Plant; Administration Building; Civilian Employees' Building; Noncommissioned Officers' Quarters; Engine Storage and Machine Shop; Foundry; Fire Station; Guard House; Quartermaster Storehouse; Commissary Storehouse; Aircraft Construction Shop; Ordnance and Signal Corps Storehouse; Truck Shed; Post Exchange Building; Hospital; Wind Channel Building; Stable; Observation Towers; Dynamometer Building; Enamel Baking Building; Commissioned Officers' Quarters; Bakery; Producer Gas Plant; Garage; Hospital Stewards' Quarters; Wood and Coal Shed; Lunch Room; Boat House and Dock; Flag Staff; Gasoline Storage; Radio Towers; Water Tower, and as many other buildings as may be ordered hereafter."

(9) 1. 313.6 and Ind., Hq Army Air Base, Langley Field, Va., to: The Adjutant General, Wash., D.C., 14 Feb 43, subj: "Disposition of Illegible Records."

(10) 2. Recapitulation of Costs, Langley Field Project, Hampton, Va., from combined accounts of contractors and Government, June 1917 to March 1919.

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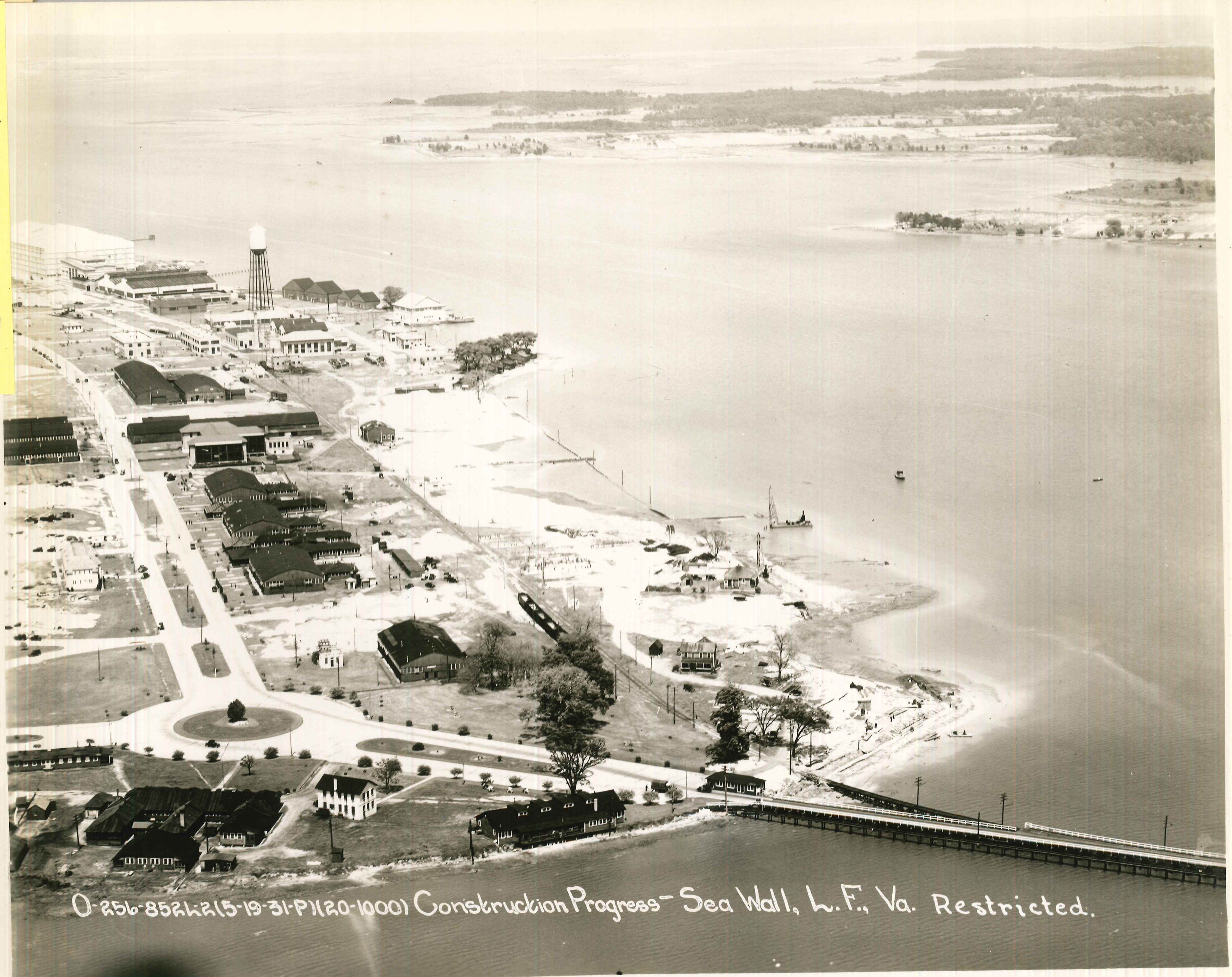

0-256-852L-2(5-19-31-P)(20-1000) Construction Progress - Sea Wall, L.F., Va. Restricted.

For appendices

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at least partial figures. The cost of the seaplane hangar and boat house, for example, are given as $245,000 and $126,619, respectively. The airship hangar, finished in 1919, cost an estimated $510,000 or more, this figure including extensive alterations and an adjoining machine shop, both completed in 1922. With the exception of additional quarters in the lighter-than-air area, which cost an estimated $231,000, no further significant items of early construction are on record.

In reviewing the cost of construction through 1922, there is evidence of expenditures totalling approximately $8,500,000. This is a minimum cost figure, but anything above this total is a matter of conjecture.

At the beginning of 1923, the date which roughly marks the termination of the first period of construction, permanent structures on the main base, exclusive of NACA, consisted of the following structures: base headquarters building (originally designed as a laboratory); boat house; seaplane hangar used primarily as a warehouse; engine storage and machine shop (later the post exchange and commissary); two airplane hangars (later machine and aero-repair shops); garage and technical stores building (later annex to the base garage and quartermaster carpenter shop); Lawson and Dodd Halls (BOQ); 26 two-family officers' quarters originally built as dwellings for civilian employees of the NACA; and the utilities systems.

The airship or dirigible hangar (later used as a reclamation shop for damaged planes), the gas generator plant and compressor station, and a small number of officers' quarters (later used by noncommissioned officers) were the first major permanent installations in the lighter-than-air area.

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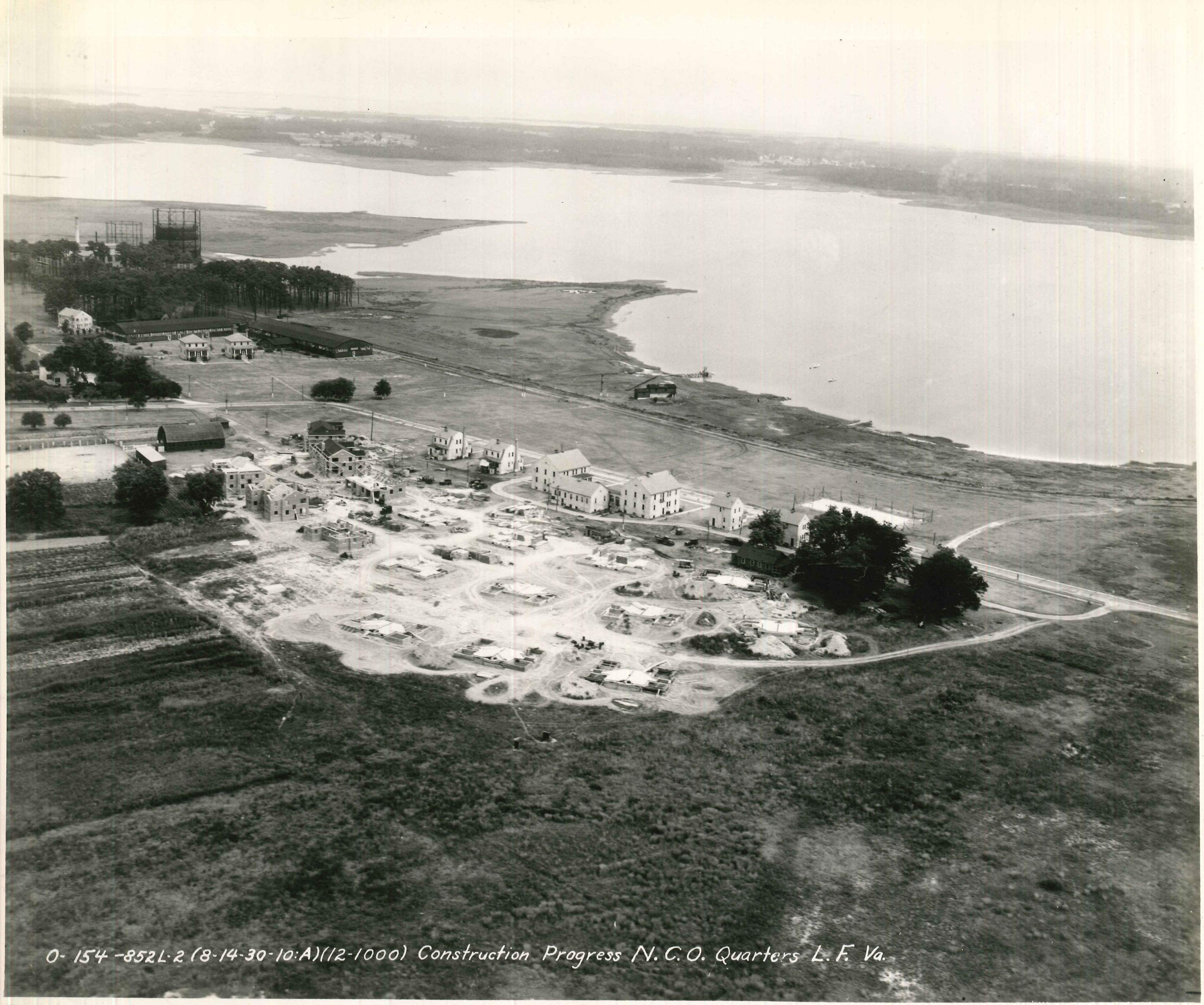

0-154-852L-2 (8-14-30-10:A)(12-1000) Construction Progress N.C.O. Quarters L.F. Va.

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Virtually all the remaining buildings -- hangars, barracks, mess halls, hospital facilities -- were of sheet iron or steel and stucco construction. The hangar line consisted of about fifteen steel-frame, corrugated-roof type and two brick hangars. These, with three or more other buildings were situated along the north side of Nealy Avenue, and estended from Hammond Boulevard to Douglas Street.

During the years of 1933 to 1935, one of the principal construction projects on Langley Field was the grading and seeding of the officers' quarters area, and an area along the seawall, The project was authorized by the Quartermaster General and supervised by the Public Works Administration. The contract was let on 8 November 1933; however, the completion report,[1] which showed a cost of $19,856, was not submitted until 1935.

Expansion of Site

As Table I, below, indicates, the original purchase on 30 December 1916 was followed by a succession of six other acquisitions before 1935; however, most of the permanent structures built on or for Langley Field were located on the original tract. The "Big Marsh", a bombing range, was bought from F. W. Darling, a prominent local oyster dealer.[2]

Mulberry Island was purchased by the War Department from 153 private

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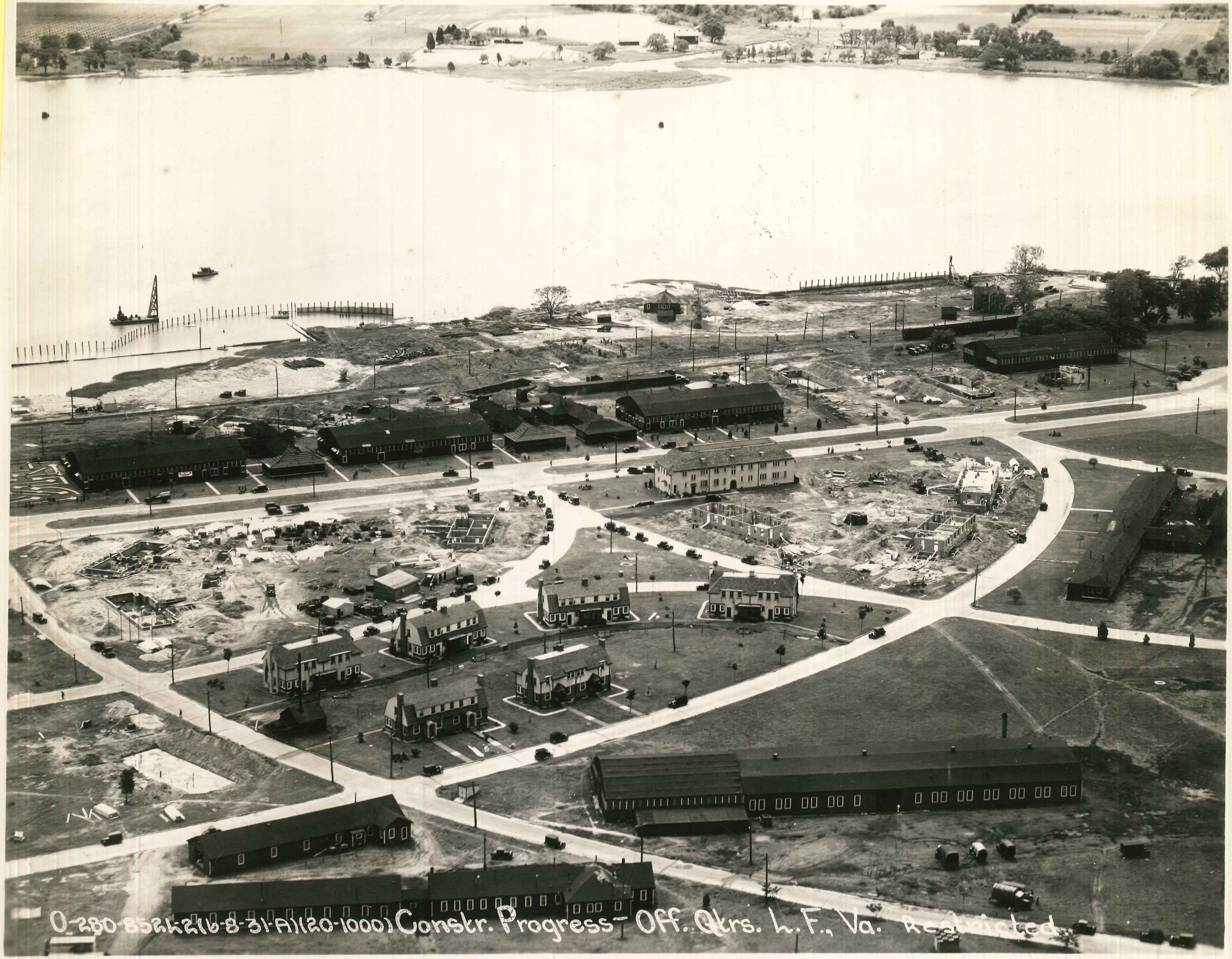
(11) 1. CQ 615, War Dept., Office of the Constructing Quartermaster, Langley Field, Va., to: The Quartermaster, Langley Field, Va., 18 Jan 35, subj: "Completion Report."

(12) 2. Deed, F. W. Darling and wife, to: United States of America, 1 Sep 17, transferring 3253.75 acres for $5,645.31. Deed recorded in Deed Book 37, p. 353 of the Public Records of the County of York, Va.



0-280-8524-2(16-8-31-A)(20-1000) Constr. Progress- Off. Qtrs. L.F., Va. Restricted

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owners in 1918. The site was intended for use by the Coast Artillery, and for that purpose Fort Eustis was constructed thereon. The island did not come under the supervision of Langley Field for use as a maneuver area and bombing range until September 1936.[1]

TABLE I. LAND ACQUISITIONS BEFORE 1935:
SITE, DATE, COST, LANGLEY FIELD, VA.

Site	Date	Cost	Acreage
Original purchase	30 Dec 16	$290,000.00	1,659.8
The Big Marsh and Egg Island	1 Sep 17	5,645.31	3,059.25
Mulberry Island *	Feb-Jun 18	538,000.00	7,983
Plum Tree Island and Arundel properties	28 May 20	1,500.00	194.5
Ditch near Shellbank	26 Apr 29	1.00	1.38
Approach to Air-strip	30 March 34	5,132.60	46.66
Three lots on Back River	Mar-Apr 34	3,100.00	.908
Approximate totals:		$843,378.91	12,935.698

* Purchased for the Coast Artillery

Plum Tree Island[2] and adjacent property were acquired by condemnation proceedings from the Arundel Sand and Gravel Company for use as a bombing

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(13) [1] Extracts, History of Fort Eustis (Mulberry Island), Va., Office of the Adjutant, Fort Eustis, Va.

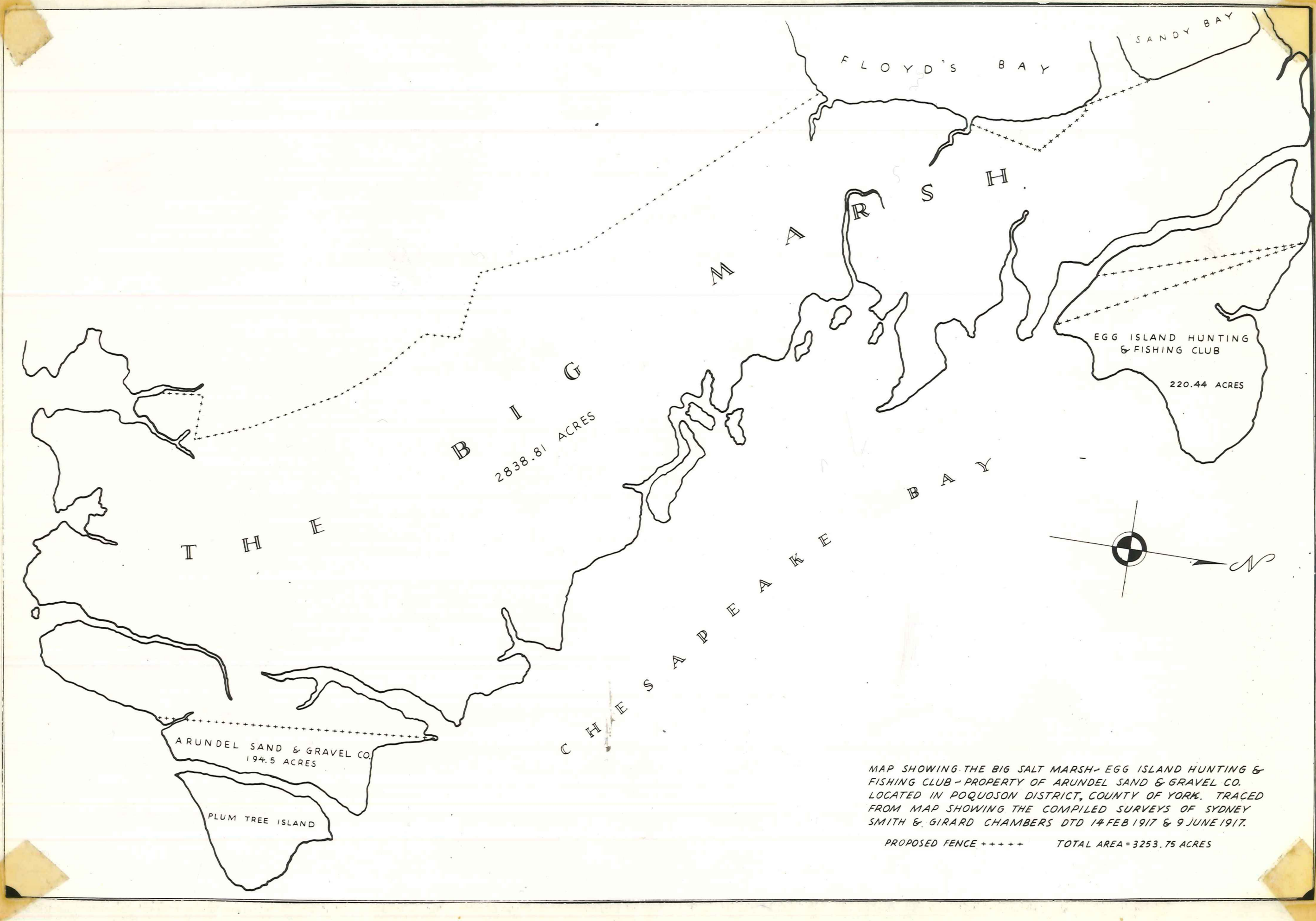
(14) Note: Mulberry Island lies in Warwick County, Va. See map of Mulberry Island, Warwick County, Va., 1927

[2] Recorded in Deed Book 38, p. 13, York County, Va. As late as 1944 there was a question as to whether or not Plum Tree Island was a part of the property named in the condemnation proceedings.

range. Contiguous to the "Big Marsh", this land was a logical [illegible] expansion.

In 1929 the Government purchased from the Hampton Normal and Agricultural Institute, a narrow strip of land along the southwestern border of the original tract.[1] The apparent reason for this purchase was the need for improving drainage.

A corner of Shellbank Farm was bought from Hampton Normal and


FLOYD'S BAY
SANDY BAY
THE BIG MARSH
2838.81 ACRES
EGG ISLAND HUNTING & FISHING CLUB
220.44 ACRES
CHESAPEAKE BAY
N
ARUNDEL SAND & GRAVEL CO.
194.5 ACRES
PLUM TREE ISLAND
MAP SHOWING THE BIG SALT MARSH – EGG ISLAND HUNTING & FISHING CLUB – PROPERTY OF ARUNDEL SAND & GRAVEL CO. LOCATED IN POQUOSON DISTRICT, COUNTY OF YORK. TRACED FROM MAP SHOWING THE COMPILED SURVEYS OF SYDNEY SMITH & GIRARD CHAMBERS DTD 14 FEB 1917 & 9 JUNE 1917.
PROPOSED FENCE + + + + +
TOTAL AREA = 3253.75 ACRES

THE BIG MARSH, YORK COUNTY, VIRGINIA.
BOMBING RANGE FOR LANGLEY FIELD

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[1] Deed Book No. 82, page 530, of the Public Records of Elizabeth City County, Va.

Agricultural Institute in 1934 so that a highway might be constructed and trees cleared along the southwest coundary of the original tract, connecting with the Yorktown highway to the west.[1]

During March and April 1934, three lots across the Back River from the original tract were acquired from the F. W. Darling, C. C. Curtis, and V. P. Wilson families for the purpose of providing sentry houses and some ground at the approaches to the new concrete bridge built in 1934. Other parcels of land were added to Langley Field, but after 1935, and therefore they have been recorded in subsequent installments of the history of Langley Field.

Summary

The painstaking seeds of experimentation sown by Samuel P. Langley grew to fruition with the founding of the Langley Memorial Aeronautical Laboratory on land purchased in 1916. Enterprising Hampton citizens, and the favorable geographic position of the Virginia "Peninsula," combined to locate the Aeronautical Experimental Station four miles north of Hampton, where conditions promised to be extremely favorable for experimentation with both land-based aircraft and seaplanes. Delays in construction, however, prompted the Army and Navy to secure alternate experimental fields, leaving the National Advisory Committee for Aeronautics as the only tenants of the field for a brief period.

Between the years 1917 and 1919 the Army renewed its interest in

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[1] Deed Book 90, page 355, of the Public Records of Elizabeth City County, Va.

Langley Field, and by 1935 Army buildings and activities had so grown in number that the NACA was more nearly a partner than a host on the field. The original site had grown from 1,650 acres, more or less, of swampy tidewater soil to an area of over 12,000 acres. The Army's need for bombing ranges was responsible for the purchase of several isolated areas, where experimental bombing and strafing, as well as routine training could be conducted. Heavier loading of planes made longer runways necessary, and the nearness of the field to the sea made drainage difficult -- to list a few factors that required expansion and new construction. Through the addition of a Public Works Administration landscaping and seeding program during the "lean" years from 1932 to 1935, the field acquired beauty commensurate with its importance in the world of aviation.

The next chapter of this history is devoted to the story of Army units assigned to Langley Field from its date of designation as a military installation to 1935.

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CHAPTER 2

MILITARY UNITS ASSIGNED

Langley Field: Air Service, Signal Corps

The first contingent of military personnel arrived at the "Aviation Experimental Station and Proving Ground," as Langley Field was variously called, about the middle of June 1917. On 1 July 1917, military personnel of the field consisted of two officers and 65 enlisted men.[1]

Major John C. Bartholf, Signal Corps, was the first commanding officer of the new station; his tenure of office extended from July 1917 until 14 September 1917.[2] The original unit under Major Bartholf was the 5th Aviation School, Signal Corps, which was redesignated as the 119th Aero Squadron on 2 September 1917.[3] Soon thereafter, on 18 November 1917, a Photo School Detachment was formed and became a part of Langley Field, as

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1. Figures drawn from History of Langley Field, by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS. This manuscript is in the files of the Base Historical Office, Langley Field, Va. In documenting this chapter on military units assigned to Langley Field during the early years, the historian was greatly limited in scope, partly due to the loss of records of the early period as the result of a flood in 1933. Fortunately, however, monthly Sick and Wounded Reports covering the period from October 1917 through December 1931 were available and supplied much of the information in this chapter, as well as providing verification of facts in the Dixon-Gordon manuscript. Also used as sources were monthly Venereal Reports and Post Exchange Minutes, virtually a monthly summary of units on the field from 5 October 1933 until 1935.

(15) 2. List of Commanding Officers, Langley Field, Va., July 1917 to March 1935.

(16) 3. Sick and Wounded Report, Langley Field, Va., Oct 1917

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MAJ. JOHN C. BARTHOLF

Commanding Officer
July 1917 to 14 September 1917

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the site had been designated by the War Department on 7 August 1917.[1]

Lieutenant Colonel William Lay Patterson, Signal Corps, the second commanding officer, assumed command of Langley Field in October 1917, and remained in command until June 1918.[2] Under Colonel Patterson, the experimental activities of the War Department at Langley Field in 1917 were augmented by a school for aerial photographers and observers.[3] A little later, a pilot school got under way.[4]

On 21 December 1917, the 203rd Aero Construction Squadron arrived at Langley Field.[5] Therefore, on 31 December 1917, military personnel on Langley Field consisted of the 308th and 119th Aero Squadrons, Air Service Signal Corps Detachment, 203rd Aero Construction Squadron, Photo School Detachment, Medical, Quartermaster Corps and Ordnance Detachments, totalling a mean strength of 38 officers and 409 enlisted men.[6]

During the next few months, many changes occurred in the organizations and personnel at Langley Field as they strove to keep pace with the program

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[1] Par. 1, G.O. 104, War Dept., Wash., D.C., 7 Aug 17.

(15) [2] List of Commanding Officers, Langley Field, Va., Jul 1917 to Mar 1935.

[3] History of Langley Field, by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

[4] *Ibid*.

[5] Sick and Wounded Report, Langley Field, Va., Dec 1917.

[6] *Ibid*.

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LT. COL. WILLIAM LAY PATTERSON

Commanding Officer
October 1917 to June 1918

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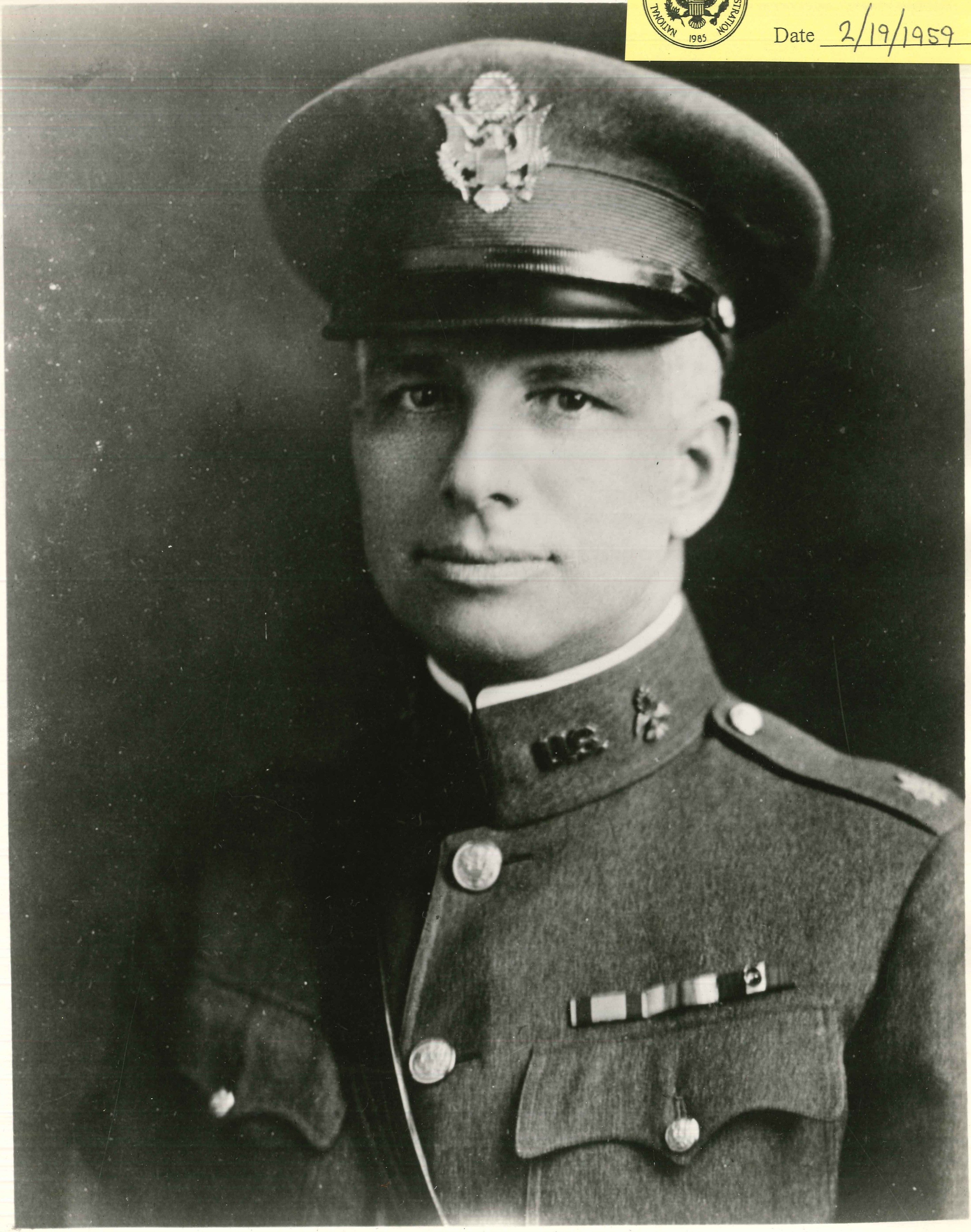

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laid down by the War Department upon the entry of the United States into World War I. During the month of February 1918, the 203rd Aero Construction Squadron was redesignated as the 499th Aero Construction Squadron; the Photo Detachment was designated the 363rd Depot Aero Squadron, and the 498th Aero Squadron was added.[1] On 6 March 1918, the Air School became known as the School of Aerial Observers and the 363rd Depot was designated as Detachment A. S. S. C. Photo.[2]

On 13 April 1918, the 504th Aero Squadron arrived at Langley from Camp Vail.[3] This squadron remained only a few months and then was transferred from this field on 10 July 1918.[4] The 611th Aero Squadron arrived at Langley on 24 June 1918.[5]

Major Clinton W. Howard, A. S., assumed command of Langley Field in August 1918 and remained in command until January 1919.[6] On 11 July 1918, the 34th, 35th and 36th Labor Companies were formed and on 29 July 1918, the 505th Aero Squadron arrived at Langley Field.[7] On 4 August 1918, the 500th Aero Squadron arrived, followed on 7 August 1918 by the 502nd Aero

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[1] History of Langley Field, by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

[2] Ibid

[3] Sick and Wounded Report, Langley Field, Va., Apr 1918.

[4] Sick and Wounded Report, Langley Field, Va., Jul 1918.

[5] Sick and Wounded Report, Langley Field, Va., Jun 1918.

(15) [6] List of Commanding Officers, Langley Field, Va., Jul 1917 to Mar 1935.

[7] Sick and Wounded Report, Langley Field, Va., Jul 1918.

Squadron.[1] Three additional construction companies--the 28th, 29th and the 30th--were assigned to Langley Field in August 1918.[2] On 12 August 1918, several changes were made in the names of organizations. The 611th Squadron was changed to Detachment No. 18, the 119th Squadron became Detachment No. 11, and the 368th became Detachment No. 17.[3] During August 1918, many changes occurred at Langley: the Balloon Detachment was formed; the designation of the School for Aerial Observers changed to Air Service Flying School (A.S.F.S.) with the personnel divided into three squadrons, A, B, and C.[4] The mean strength of the Field in August 1918 was 3,459 men, including 289 officers, 1,989 white troops and 1,181 colored troops.[5]

During October 1918, the 499th, 500th, 502nd and 505th Aero Squadrons left Langley Field.[6] Also, the 28th, 29th, 30th, 31st, 32nd, 33rd, 34th, 35th, 36th, and 37th Labor Companies or Construction Companies were formed into one Battalion, known as the Labor Battalion, consisting of 2,301 men.[7] In October 1918 the mean Field strength of 4,563 men included 349 officers,

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[1] Sick and Wounded Report, Langley Field, Va., Aug 1918.

[2] Ibid.

[3] History of Langley Field, by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

[4] Ibid.

[5] Sick and Wounded Report, Langley Field, Va., Aug 1918.

[6] Sick and Wounded Report, Langley Field, Va., Oct 1918.

[7] History of Langley Field, be Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS

1,926 white troops and 2,288 colored troops.[1]

On 13 November 1918, the 504th Aero Squadron was assigned to Langley Field.[2] On 16 November 1918, Squadrons A, B, and C were reformed into the Air Service Flying School.[3] On 16 and 17 November, the 20th and 21st Construction Companies, respectively, were assigned to Langley Field. The 501st Aero Squadron arrived on 18 November 1918.[4]

By the end of the war, the Army experimental activities had been transferred to McCook Field, Dayton, Ohio leaving this station occupied by tactical units.[5]

After the Armistice, a gradual reduction of the Labor Battalion (Colored) was made and, on 31 December 1918, the remaining personnel, 242 men, were carried as Casuals until such time as they were discharged. On 31 December 1918, the total strength of Langley Field, exclusive of colored casuals, was 240 officers and 1,936 enlisted men.[6]

Major Frank D. Lackland, A. S., assumed command of Langley Field during January 1919, and remained in command until May 1919.[7]

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1. Sick and Wounded Report, Langley Field, Va., Oct 1918.
2. Sick and Wounded Report, Langley Field, Va., Nov 1918.
3. *Ibid.*
4. *Ibid.*
5. History of Langley Field, by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. *MS.*
6. Sick and Wounded Report, Langley Field, Va., Dec 1918.

(15) 7. List of Commanding Officers, Langley Field, Va., Jul 1917 to March 1935.

The ending of the World War brought about the demobilization of many organizations, and beginning in January 1919 a general reorganization of the Army took place. On 8 January 1919, the 501st, 504th, and the 626th Aero Squadrons and the 20th and 21st Construction Companies were disbanded.[1] In the same month Squadron C consolidated with Squadrons A and B. On 13 February 1919, these two squadrons were formed into the Air Service Flying School Detachment. The 17th and 18th Detachments were gradually reduced, until at the end of January 1919, what was left of both organizations was transferred to Detachment No. 11.[2] The 61st Balloon and 71st Balloon were assigned to Langley Field on 3 March 1919.[3] On 4 March 1919 the 840th and 488th Aero Squadrons arrived at Langley and were almost immediately disbanded.[4] A skeleton organization of the 196th Aero Squadron arrived at Langley on 21 March and was dissolved by 28 March 1919. During the latter part of March 1919, the Balloon Wing, A. E. F., and the 5th Air Park reported to Langley Field and both organizations were immediately demobilized. On 25 March 1919, the 12th and 34th Balloon Companies reported to Langley. The 12th Balloon Company was demobilized, along with practically the entire organization of the 34th. The 61st Balloon was disbanded on 4 April 1919.[5]

During the period from 18 May 1919 to 8 July 1919, Langley Field was commanded by Colonel William N. Hensley, A. S.[1]

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[1] Sick and Wounded Report, Langley Field, Va., Jan 1919.

[2] Ibid.

[3] History of Langley Field, by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS

[4] Ibid.

[5] History of Langley Field, by Letta E. Dixon and Lydia Gordon secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS

On 25 May 1919, Detachment 11, A. S. P., was disbanded and the personnel absorbed in other organizations present at Langley Field. The personnel of the 71st Balloon Company was absorbed by the 34th Balloon. On 17 June 1919, the 74th Aero Squadron arrived at Langley Field.[2]

In July 1919, the command of Langley Field was again changed. Colonel T. F. Dodd, A. S., assumed command, remaining in command until October 1919.[3]

The 59th Balloon Company arrived at Langley Field on 19 July 1919, and was disbanded without delay. On 24 July 1919, the 19th Balloon Company was assigned to Langley Field. This company was originally organized at Fort Omaha, Nebraska, 24 January 1918. It was stationed at that post until September 1919, when orders were issued sending the organization to the Aeronautical General Supply Depot and Concentration Camp, Camp Morrison, Virginia. At this camp, the Company was equipped and final preparations made for overseas service. The company sailed from Newport News, Virginia, on 21 October 1918, arriving at Brest on 3 November 1918. The Company was stationed with the U. S. Balloon School at Camp DeSouge until February 1919, when orders were received sending it back to the United States. The 19th

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(15) 1. List of Commanding Officers, Langley Field, Va., Jul 1917 to Mar 1935.

2. History of Langley Field, by Letta E. Dixon and Lydia Gordon secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

(15) 3. List of Commanding Officers, Langley Field, Va., Jul 1917 to Mar 1935.

sailed on 4 April 1919, arriving at Mitchel Field on 19 April, where the company was demobilized, but again reorganized at Langley on 24 July 1919.[1]

On 7 August 1919, the 28th Balloon Company arrived and on 11 August, the 29th Balloon Company arrived. Both of these organizations were demobilized on 8 October 1919. On 4 September 1919, Headquarters Detachment, Second Observation Wing, reported to Langley, and on 22 September, the 10th Balloon Company reported. The 74th Aero Squadron was redesignated the 88th Aero Squadron on 25 September 1919.[2]

The 50th Aero Squadron (Observation) was assigned to Langley Field on 2 October 1919.[3] This squadron was organized at Kelly Field, Texas, 6 August 1917. On 28 December 1917, the squadron with full equipment left Kelly Field for New York. The squadron left Hoboken, New Jersey, on 9 January 1918, to join the A. E. F. They landed at Liverpool on 24 January 1918. From then until 13 July, the squadron was attached to the Royal Air Forces for training, being stationed at Romsey, Harlazton, and Winchester. The 50th was then sent to France, arriving there 14 July 1918. During the St. Mihiel offensive (September 12th to 16th), the squadron was actively engaged in reconnaissance, infantry-contact patrols, and "artillery reglage" for the 82nd and 90th Divisions. On 23 September 1918, the squadron was actively engaged on the Argonne Front working with the famous 77th Division.

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[1] History of Langley Field, by Letta E. Dixon and Lydia Gordon secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

[2] Ibid.

[3] Sick and Wounded Report, Langley Field, Va., Oct 1919.

It was about this time that the famous battalion of the 77th Division was lost in the Argonne Forest. However, due to the efforts of two members of the 50th Aero Squadron, "The Lost Battalion" was found, and members of the squadron were detailed to drop supplies and ammunition to them. Several members of squadron were fatally wounded in carrying out these missions.

From the beginning of November 1918, until the close of hostilities, the 50th Squadron was with the First Army, A. E. F., in the Argonne. During that time, the squadron was assigned for aviation duties with the 78th Division.[1]

When the Armistice was signed, the squadron was stationed at Clermonten-Argonne, after having gone through the St. Mihiel and Argonne Meuse offensives with such an excellent record and with such a display of valor at all times that it was an inspiration to other organizations.[2]

After the Armistice was signed, the 50th Aero Squadron was relieved from further duty with the Observation Group, First Army Corps, and divided into three flights. During April 1919, however, the squadron was reassembled and left France on 22 April 1919, arriving in New York on 8 May 1919, with a personnel strength of ten officers and 168 enlisted men. At debarkation, the organization was sent to the Aviation Concentration Camp, Garden City, L. I., and discharged a great many of its men. The outfit was then sent to Scott Field, Belleville, Illinois, but was reorganized at Langley Field, on

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[1] History of Langley Field, by Letta E. Dixon and Lydia Gordon secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

[2] Ibid.

2 October 1919.[1]

Major John N. Reynolds, A. S., assumed command of Langley Field early in October, 1919.[2]

On 25 November 1919, the detachment which remained of the Air Service Flying School was changed to a Casual Detachment and gradually reduced by transfer and discharge.[3] Also during November 1919, Headquarters 1st Aero Observation Group was assigned to Langley Field.[4] On 13 December 1919, the 7th Photo Section was assigned to Langley Field.[5] The organizations on the field on 31 December 1919, consisted of Headquarters, 7th Photo, 88th Aero Squadron (Obs.), 50th Aero Squadron (Obs.), U. S. A. S. A. P (Photo School), 10th and 19th Balloon Companies, 1st A. O. G., 2nd Observation Wing, Medical and Q. M. C. Detachments - a total of 59 officers and 963 enlisted men.[6]

On 23 January 1920, the 2nd and 12th Photo Sections were assigned to Langley Field. The designation of the 12th Photo was changed to the 14th Photo Section during the latter part of January 1920. These two sections were organized by the transfer of men from the U. S. Army School of Aerial Photography and the 7th Aerial Photographic Section, and by the assignment of unassigned enlisted men attached to the School of Aerial Photography.

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[1] History of Langley Field, by Letta E. Dixon and Lydia Gordon secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

(15) [2] List of Commanding Officers, Langley Field, Va., Jul 1917 to Mar 1935.

[3] Sick and Wounded Report, Langley Field, Va., Nov 1919.

[4] Ibid.

[5] Sick and Wounded Report, Langley Field, Va., Dec 1919.

[6] Ibid.

On 9 February 1920, the Second Photo Section was transferred to Kelly Field, Texas, and the 14th Photo was transferred on 16 February 1920. On 12 March 1920, the 26th Balloon Company was assigned to Langley Field and dropped from the records on 3 May 1920. The 6th Photo Section was picked up on the Langley records on 1 April 1920 and dropped 30 April 1920.[1]

On 17 April 1920, Major John N. Reynolds, A. S., relinquished command of Langley Field to Colonel William N. Hensley, A. S. a former commander of the field. Colonel Hensley remained in command until 15 July 1921.[2]

The designations of the 10th and 19th Balloon Companies were changed to 10th Airship Company and 19th Airship Company, respectively, on 18 April 1920.[3] On 19 April 1920, the 4th Photo Section was formed and transferred on 29 April 1920.[4]

In July 1920, Major T. D. Milling was ordered to Langley Field to establish the Air Service Field Officers' School, a detachment.[5] The school's designation was changed to Air Service Tactical School in March 1923,[6] and continued in operation until 1 July 1931 when it was moved to Maxwell Field,

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[1] History of Langley Field, by Letta E. Dixon and Lydia Gordon secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

(15) [2] List of Commanding Officers, Langley Field, Va., Jul 1917 to Mar 1935.

[3] Sick and Wounded Report, Langley Field, Va., Apr and May, 1920.

[4] History of Langley Field, by Letta E. Dixon and Lydia Gordon secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

[5] *Ibid*.

[6] Sick and Wounded Report, Langley Field, Va., Mar 1923.

Alabama. An elaboration of the activities of this unit while at Langley Field may be found in Chapter Three of this history.

On 21 December 1920, the 258th Heavy Bombardment Squadron arrived at Langley Field. On 31 December 1920 the strength of the field was 77 officers and 693 enlisted men.[1]

On 28 March 1921, the 1st A. O. G. changed to the 7th Group, Observation, and the 258th Heavy Bombardment Squadron was redesignated the 14th Squadron (Bombardment).[2]

Lieutenant Colonel C. H. Danforth, A. S., assumed command of Langley Field in July 1921 and remained in command until June 1924.[3]

On 1 October 1921, Air Park Company No. 3 was formed by the transfer of members from the Air Service Supply Detachment, Mitchel Field, N. Y. The designation of the Airship Company No. 10 was changed to the Airship School Detachment. On 15 October 1921, the personnel of the 88th Observation Squadron were transferred to the 50th Squadron and the organization, in name only, was transferred to another field. On the same date, the 7th Photo Section was absorbed in the Photo School.[4]

On 26 October 1921, the 1st Squadron (Observation), 5th Squadron (Observation), the 49th Squadron (Bombardment), and the 96th Squadron (Bombardment),

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1. History of Langley Field, by Letta E. Dixon and Lydia Gordon secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

2. Ibid.

(15) 3. List of Commanding Officers, Langley Field, Va., Jul 1917 to Mar 1935.

4. History of Langley Field, by Letta E. Dixon and Lydia Gordon secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

BRIG. GEN. C. H. DANFORTH

Commanding Officer, July 1921 to June 1924
Commanding General, June 1934 to March 1935

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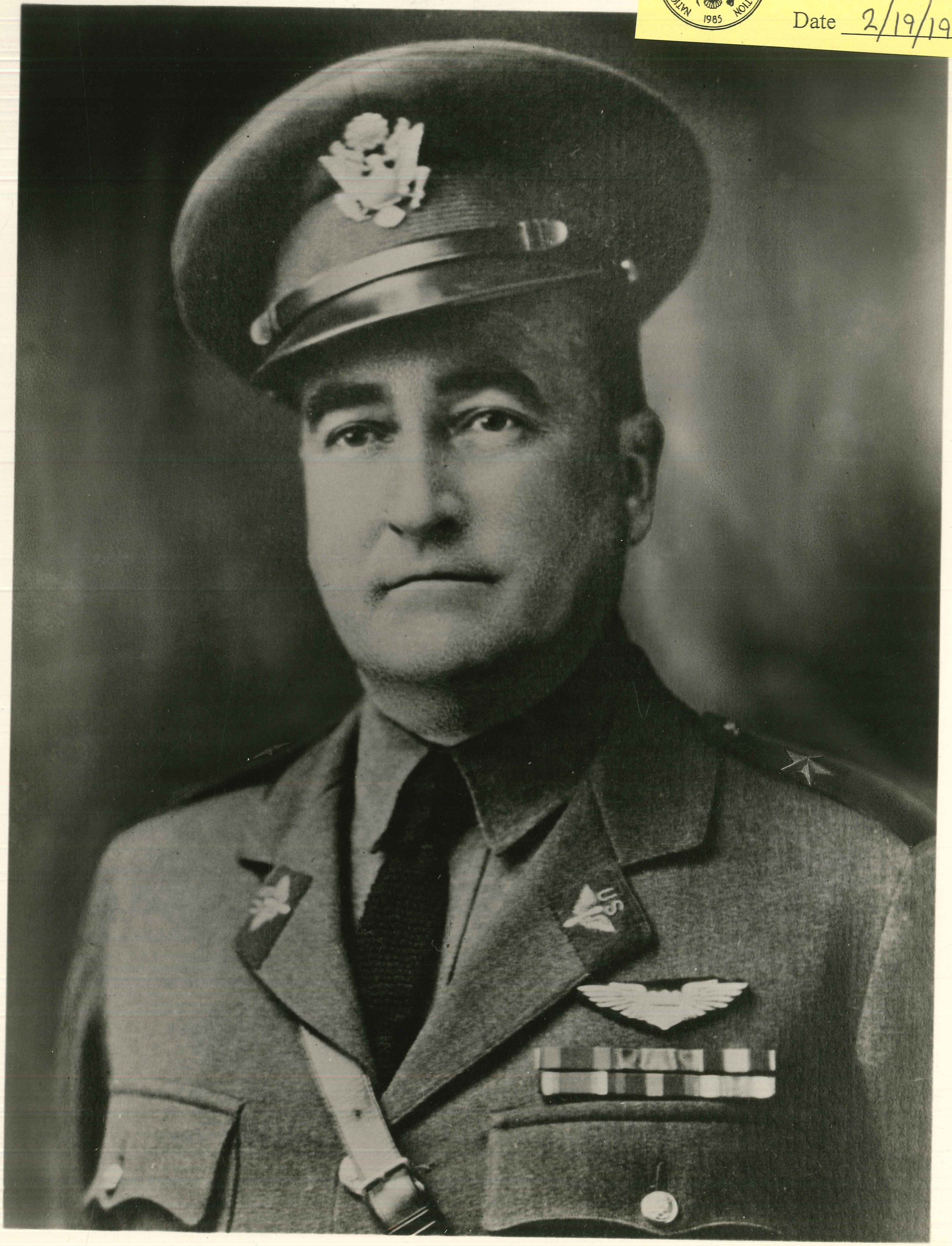

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having completed their work in connection with the bombing project "B", as the bombing of the ex-German ships was called, returned to their proper stations.[1]

On 31 December 1921, the personnel assigned to Langley Field consisted of 109 officers and 529 enlisted men.[2]

On 30 June 1922, many changes occurred at Langley Field. The 14th Bombardment Squadron was demobilized and personnel transferred therefrom into other organizations at Langley Field. The U. S. Army School for Aerial Photography was transferred to Chanute Field, Illinois, on 30 June 1922, and the Airship School was transferred to Scott Field on the same date.[3]

On 1 July 1922, the Second Bombardment Group joined Langley Field from Kelly Field, Texas. The Second Group consisted of Headquarters, Second Photo Section, Air Park No. 4, 11th Squadron, 20th Squadron, the 49th Squadron.[4] This group was originally organized at Moulon, France, 10 September 1918. It consisted of the 96th, 11th and 20th Squadrons, 464th Construction Squadron and the 12th Photo Section. On September 18, the 116th Squadron joined the group, completing its organization. The group at this time was known as the 1st Day Bombardment Group. It operated as a group during each day of the St. Mihiel offensive--the 96th Squadron doing the major portion of the work. During the Meuse-Argonne offensive the group dropped more than 1,264 tons of bombs on important objectives.[1]

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[1] History of Langley Field, by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

[2] *Ibid*.

[3] Sick and Wounded Report, Langley Field, Va., Jun 1922.

[4] Sick and Wounded Report, Langley Field, Va., Jul 1922.

On 8 August 1922 the Second Wing was organized in accordance with instructions from the Chief of Air Service in a letter dated 28 July 1922. The following units made-up the Second Wing: Second Group (Bombardment); 50th Squadron (Observation); Air Park No. 3; Photo Section No. 20; Airship Company No. 19; and Field Officers' School.[2]

The Airship Company No. 19 was redesignated as the 19th Airship Company, and Air Park No. 3 became the Third Air Park in October 1922. At the end of 1922, the military strength of Langley Field was 89 officers and 987 enlisted men.[3]

In January 1923 the designation of certain organizations were changed in accordance with General Orders 39, W. D., 1922, and in compliance with Circular 112, W. D. OCAS, dated 22 December 1922, as follows: the Second Bombardment Group became the Second Bombardment Group, Headquarters Detachment; Air Park No. 4 became the 59th Service Squadron; the 11th, 20th, 49th, and 96th Squadrons (Bombardment) became the 11th, 20th, 49th, and 96th Bombardment Squadrons; the 50th Squadron (Observation) became the 50th Observation Squadron; and the 3rd Air Park became the 58th Service Squadron. The Field Officers' School was redesignated the Air Service Tactical School

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1. History of Langley Field, by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. *MS*.

2. *Ibid*.

3. *Ibid*.

in March 1923. No other changes in units or their names were made in 1923, and at the end of the year 67 officers and 1,207 enlisted men were stationed at Langley Field.[1]

By 1924 definite policies relating to the Air Service had been adopted and very few changes in the designation and station of the various organizations were made thereafter.

Lieutenant Colonel Harry Graham, A. S., relieved Lieutenant Colonel Danforth as commanding officer of Langley Field in June 1924. Lieutenant Colonel Graham remained in command until September of that year, at which time Major Oscar Westover, A. S., succeeded him.[2]

At the close of 1924 military personnel at Langley Field included 84 officers and 1,142 enlisted men.[3]

All units at Langley Field retained their designated names throughout 1925, and the strength at the close of the year included 77 officers and 1,138 enlisted men.[4]

LANGLEY FIELD, AIR CORPS

The Air Service of the Army was designated as the "Air Corps" in August 1926.[5] In September of the same year, Lieutenant Colonel C. C.

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[1] History of Langley Field, by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS

(15) [2] List of Commanding Officers, Langley Field, Va., Jul 1917 to Mar 1935.

[3] History of Langley Field, by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS

[4] *Ibid*.

[5] *Ibid*.

Culver, A. C., assumed command of Langley Field and retained the position until June 1929.[1] Military personnel on the field at the close of the year consisted of 101 officers and 966 enlisted men.[2]

Three units left the field in 1927 in accordance with the Air Corps' Five Year Plan, which was approved by the War Department on 2 February 1927. The 11th Bombardment Squadron left for March Field, California, on 19 May 1927. On 22 June 1927 the 50th Observation Squadron and the 20th Photo Section departed for Brooks Field, Texas. The military strength of the field on 31 December 1927 was 122 officers and 1,095 enlisted men.[3]

Few changes in units took place in 1928, according to an organizational chart prepared during that year.[4] On 18 January 1928, the 49th Bombardment Squadron, A. C., consisting of three officers and 118 enlisted men, returned to Langley Field from Aberdeen Proving Ground, Maryland, where it had been on detached service since August 1922.[5] Also in May 1928, the Detachment of the Finance Department was dropped as a unit from the roster.[6] At the end of the year military personnel numbered 126 officers and 1,217

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(15) [1] List of Commanding Officers, Langley Field, Va., Jul 1917 to Mar 1935.

[2] History of Langley Field, by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

[3] Ibid.

(17) [4] Organizational Chart, Langley Field, Va., and 2nd Wing Air Corps, 23 Jul 1928.

[5] Sick and Wounded Report, Langley Field, Va., Jan 1928.

[6] Sick and Wounded Report, Langley Field, Va., Apr - May, 1928.

enlisted men.[1]

Lieutenant Colonel Jacob W. S. Wuest, A. C., assumed command of Langley Field on 1 July 1929.[2] On 15 November 1929, the 13th Attack Squadron, formerly the 58th Service Squadron, left Langley Field for permanent station at Fort Crockett, Texas.[3] On 31 October 1929, the 58th Service Squadron was rendered inactive.[4] The consolidated strength returns on 31 December 1929 for Langley Field showed 129 officers and 1,115 enlisted men.[5]

The following units were active at Langley Field on 1 January 1930:[6] 2nd Wing Headquarters, Air Corps; 20th Bomb Squadron, Air Corps; 2nd Group Headquarters, Air Corps; 96th Bomb Squadron, Air Corps; 49th Bomb Squadron, Air Corps; 19th Airship Company, Air Corps; Air Corps Tactical School Detachment; 59th Service Squadron, Air Corps; 2nd Photo Section, Air Corps; Detachment Ordnance Department: Detachment Medical Department; Detachment Quartermaster Corps; and Detachment Signal Corps.

No changes in units took place and the total military personnel

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[1] History of Langley Field, by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

(15) [2] List of Commanding Officers, Langley Field, Va., Jul 1917 to Mar 1935.

[3] Sick and Wounded Report, Langley Field, Va., Nov 1929.

[4] G.O. 25 & 27, Hq, 8th Corps Area, Fort Sam Houston, Texas.

[5] History of Langley Field, by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

[6] Sick and Wounded Report, Langley Field, Va., Jan 1930.

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remained about the same throughout 1930.[1] Colonel Roy C. Kirtland assumed command in July 1930.[2]

Early in 1931 two organizations were added to the Langley Field roster. The 16th Observation Squadron, Air Corps, Flight "A", arrived on the field from Fort Riley, Kansas, on 23 March 1931, consisting of five officers and 21 enlisted men.[3] On 1 April 1931 the 8th Pursuit Group Headquarters Air Corps was activated at Langley Field.[4] The Air Corps Tactical School Detachment, which included two officers and 155 enlisted men, departed for Maxwell Field, Montgomery, Alabama on 10 July 1931.[5] Also in July 1931, the Detachment Signal Corps became Detachment 16th Signal Service Company, Air Corps.[6] The December mean strength totaled 86 officers and 1,024 enlisted men.[7]

The 8th Pursuit Group Headquarters was expanded on 25 June 1932 by the reactivation of the 33rd and 34th Pursuit Squadrons and by the arrival of the 36th Pursuit Squadron from Selfridge Field, Michigan, as well as the 58th Service Squadron from Brooks Field, Texas; also the 1st Bombardment Brigade Headquarters and the 28th Communication Section were

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1. Sick and Wounded Report, Langley Field, Va., Jan-Dec 1930.

(15) 2. List of Commanding Officers, Langley Field, Va., Jul 1917 to Mar 1935.

3. Sick and Wounded Report, Langley Field, Va., Mar 1931.

4. Sick and Wounded Report, Langley Field, Va., Apr 1931.

5. Sick and Wounded Report, Langley Field, Va., Jul 1931.

6. Ibid.

7. Sick and Wounded Report, Langley Field, Va., Dec 1931.

COL. ROY C. KIRTLAND

Commanding Officer
July 1930 to July 1932

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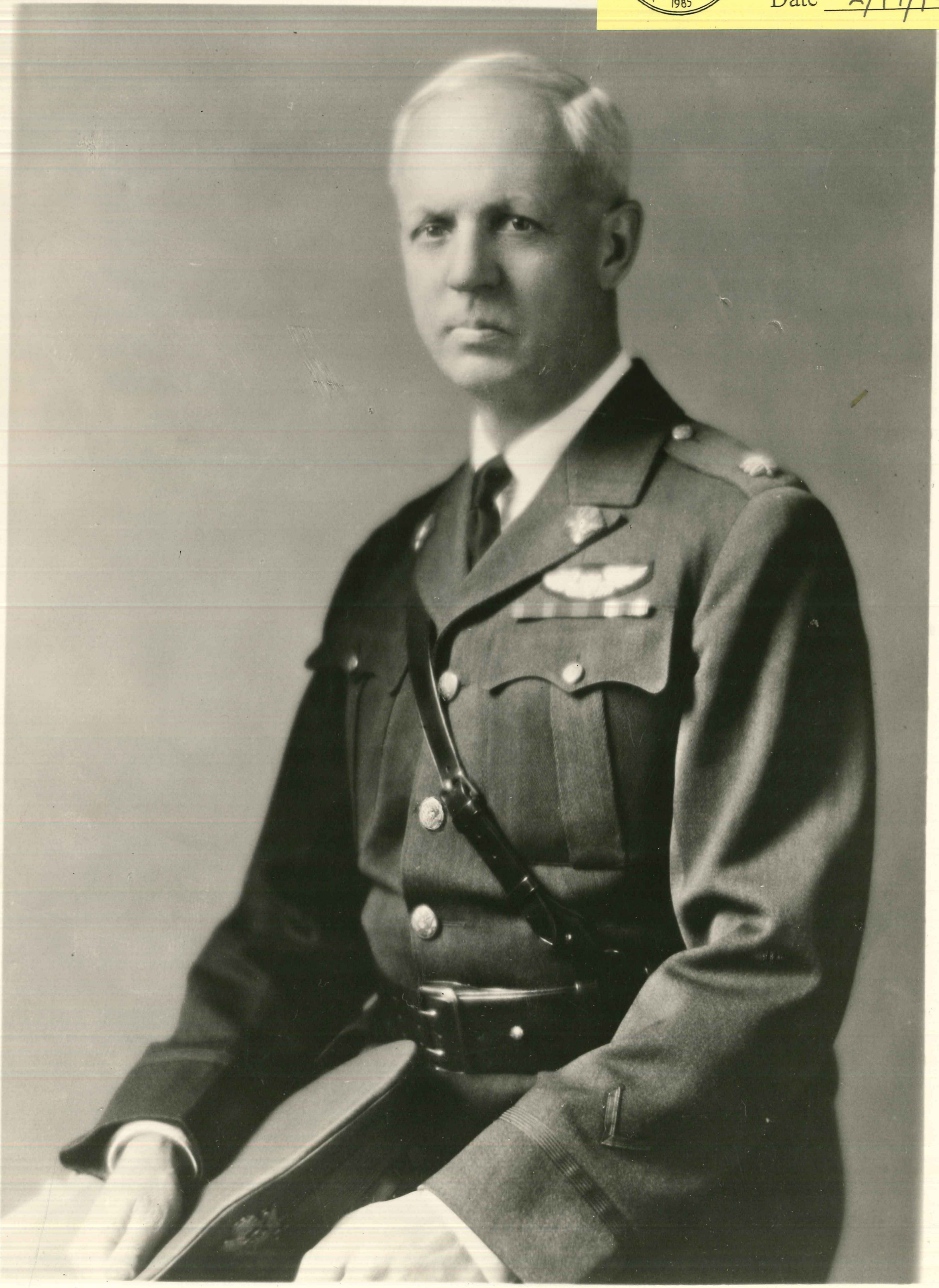

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reorganized.[1] In July Colonel C. C. Culver returned as commanding officer and relieved Colonel Roy C. Kirtland.[2] The strength of the field had increased to 156 officers and 1,389 enlisted men by the end of December 1932.[3]

The year 1933 brought few changes in units at Langley Field. In September the 37th Pursuit Squadron was added,[4] and on 13 October the designation 19th Airship Company was changed to 19th Airship Squadron.[5] Lt. Col. A. L. Sneed assumed command of Langley Field in October, relieving Colonel C. C. Culver.[6] The total strength of the field varied from a low of 1,275 men in January to a high of 1,750 men in November.[7]

Brigadier General Charles H. Danforth succeeded Lt. Colonel A. L. Sneed in June 1934 as commanding officer of the field and remained in command until March 1935.[8] The units remained the same throughout 1934 and during

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[1] G.O. 9, Hq Third Corps Area, Baltimore, Md., 7 Jun 1932.

(18) See also Memo, Hq Langley Field, Va., 3 Jul 1932, subj: "Authorized Enlisted Strength of the Air Corps Organization of this command."

(15) [2] List of Commanding Officers, Langley Field, Va., Jul 1917 to Mar 1935.

[3] History of Langley Field, by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

[4] Monthly Report of Venereal Disease in Organizations at Langley Field, Va., Sept 1933.

[5] 320.0, Langley Field, Va., 13 Oct 1933.

(15) [6] List of Commanding Officers, Langley Field, Va., Jul 1917 to Mar 1935.

[7] Monthly Reports of Venereal Disease in Organizations at Langley Field, Va., Jan and Nov 1933.

(15) [8] List of Commanding Officers, Langley Field, Va., Jul 1917 to Mar 1935.

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January and February 1935, with but two exceptions: in July a detachment of flying cadets was added and in November Post Headquarters was established as a separate unit with an original strength of 38 officers and enlisted men.[1] The total strength of the field remained about 1,700 men during this period.[2]

Summary

During the first ten years that Langley Field, Virginia, was in existence, the units operated as squadrons, detachments, and companies of the Air Service, Signal Corps. The original plans called for an extensive construction program of permanent laboratories, shops and barracks which required a considerable amount of time to complete. World War I, however, forced the entry of the United States into the struggle before the Langley Field's permanent buildings were completed. As a result, the Army's experimental activities were transferred and the field was not utilized fully during the war period.

On 1 July 1917, military personnel on the field included two officers and 65 enlisted men, and in November 1918 the maximum strength included 477 officers, 2,386 white troops and 2,269 colored troops, a total of 5,132 men. Included in the units assigned during the latter months of World War I were several Aero Squadrons, a Photo School Detachment, an Aerial Observer School, a Balloon Detachment, a Camouflage Detachment, an Air Service

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1. Monthly Report of Venereal Disease in Organizations at Langley Field, Va., Nov 1934.

2. Monthly Reports of Venereal Disease in Organizations at Langley Field, Va., Jan and Aug 1934; Feb 1935.

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Flying School and twelve construction (labor) companies. The Armistice, 11 November 1918, resulted in the discharge of nearly all the labor companies (colored) by the end of the year, and beginning in January 1919 a general reorganization of the Army took place.

The strength of Langley Field reached a low point of 117 officers and 487 enlisted men in December 1921, but from 1922 until 1932 the total strength remained constantly just over 1,000 men. From 1932 until the end of the period, 1 March 1935, the total field personnel remained above 1,500.

TABLE II. MILITARY STRENGTH, LANGLEY FIELD, VIRGINIA
(MEAN STRENGTH FOR MONTH OF DECEMBER FROM 1917 THROUGH 1931;
ACTUAL STRENGTH ON 31 DECEMBER FOR YEARS 1932 THROUGH 1934).

YEAR	OFFICER	ENLISTED	ENLISTED (COLORED)
1917	38	409	
1918*	477	2,386	2,269
1919	58	966	
1920	79	769	
1921	117	487	
1922	98	924	
1923	76	1,184	
1924	85	1,080	
1925	90	1,091	
1926	103	1,059	
1927	91	930	
1928	108	1,026	
1929	113	928	
1930	109	912	
1931	86	1,024	
1932	156	1,389	
1933	159	1,560	
1934**	119	1,546	

* November Mean Strength.

** Total Strength, 23 February 1935: 1,684, according to Report, Venereal Disease in Organizations at Langley Field, Va., February 1935.

World War I brought aircraft into prominence as useful and versatile weapons of war, and as a result more emphasis was placed on training pilots and crews in the Air Service. At Langley Field the Air Service Field Officers' School was activated in July 1920 to fill this need, and was redesignated the Air Service Tactical School in March 1923. On 10 July 1931 the Tactical School was transferred to Maxwell Field, Alabama. Finally, in August 1926, the aviation branch of the Army was divorced from the Signal Corps and became the Air Corps. The units in the Air Corps became stable and well-defined after 1926, Langley Field construction and beautification was completed in a leisurely manner, and the stage was set for the transfer of General Headquarters, Air Corps, to Langley Field immediately after this historical period.

CHAPTER 3

ACTIVITIES AT LANGLEY FIELD

Langley Field activities of the 1916-1935 period fall generally into three categories: those of the Langley Memorial Aeronautical Laboratory of the National Advisory Committee for Aeronautics, those involving heavier-than-air craft, and those concerning lighter-than-air ships. The latter two activities were Army-controlled. This chapter is divided into three sections corresponding to the three kinds of activity. From records of the NACA, an effort has been made to recount how experimentation and research have contributed to America's struggle for survival in the field of air power. Included in the heavier-than-air section is the story of the Air Corps Tactical School, and an account of the experimental bombing of battleships conducted by Brigadier General William Mitchell. A description of the "Roma" dirigible disaster is included in the lighter-than-air section.

Langley Memorial Aeronautical Laboratory of the National Advisory Committee for Aeronautics

A clause in the Naval Appropriation Act passed by Congress and signed by the President of the United States in 1915 established the National Advisory Committee for Aeronautics, bringing to its climax the long and discouraging campaign of Dr. Charles D. Walcott[1] and his confederates to secure official recognition of the need for systematic aeronautical research. Groundwork had long been laid for such an organization by the

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1. Secretary of Smithsonian Institution, 1907-1927.

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Memorial Day Aerial Parade

Langley Field, Virginia, 1925

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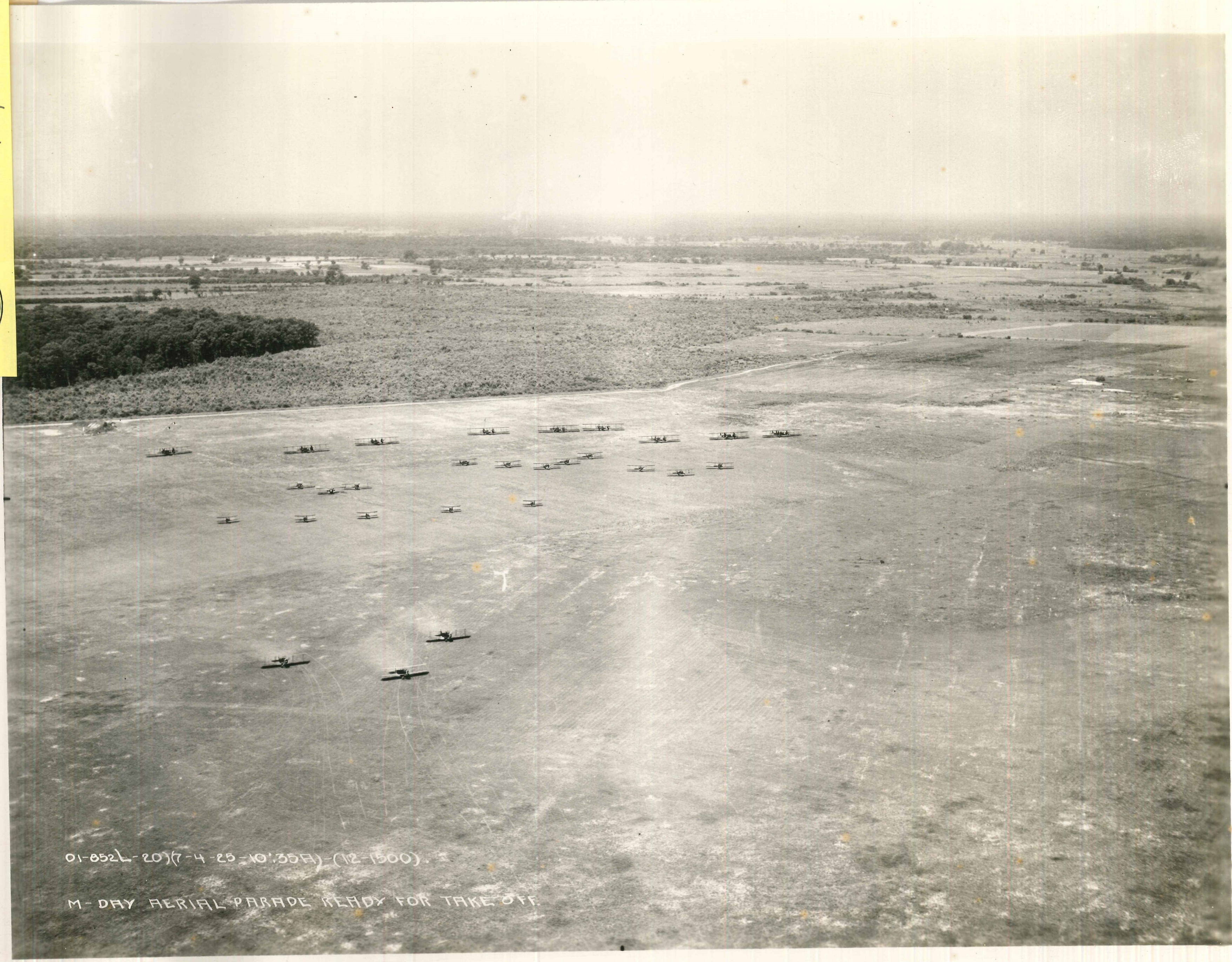

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M-DAY AERIAL PARADE READY FOR TAKE OFF.

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Smithsonian Institution, but, because of the lack of organization and cooperation between agencies engaged in experimental activities in aircraft and a general lack of funds for the specific purpose, little progress in aircraft design had been made during the years preceding World War I. The older order in the Army and Navy was not overly eager to give way to the new, and the enthusiastic proponents of aeronautics for military and commercial use met with rebuffs at every turn of the road.

The members of the NACA were appointed by the President of the United States, to serve without pay and to direct, through subcommittees, the activities of the various offices and laboratories of the committee. The twelve members included two officers from the Army, two from the Navy, one representative from the Smithsonian Institution, one from the United States Weather Bureau, one from the National Bureau of Standards, and five additional persons who were acquainted with the needs of aeronautical science, either civil or military, or skilled in aeronautical engineering or its allied sciences.[1]

In 1915, appointments to the committee were made from the outstanding military and civilian experts of the time. Table III gives the names of the members of the original committee.[2]

These men were charged to supervise and direct the scientific study of the problems of flight with a view to their practical solution. They were also empowered to determine problems which should be experimentally attacked, and consider applications thereof to practical questions of aeronautics. The act also authorized the committee to direct and conduct research and experimentation in aeronautics in such laboratories as might be placed under its direction. Five thousand dollars a year was appropriated by Congress for the activities.[1]

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[1] Public Act 273, 63rd Congress, 3 March 1915.

(19) [2] "Aeronautical Research and the NACA," S. Paul Johnson, Coordinator of NACA, submitted to "Aeronautics," 1940.

TABLE III. ORIGINAL MEMBERS, N.A.C.A., 1915.

Organization Represented	Name	Position
Army	Brig.Gen.George P.Scriven	Chief Signal Off.
Army	Lt. Col. Samuel Reber	***
Navy	Capt.Mark L.Bristoe	Director Naval Aeronautics
Navy	H. C. Richardson	Naval Constructor
U.S.Weather Bureau	Prof.Charles F.Martin	***
Bureau of Standards	Dr. S.W.Stratton	***
Smithsonian Institution	Dr.Charles D.Walcott	Sect.,Smithsonian Institution
Treasury Dept.	Byron R. Newton	***
***	Dr. Joseph S. Ames	Johns Hopkins University
***	Dr. John E. Hayford	Northwestern University
***	Dr. Michael I. Pupin	Columbia University
***	Dr. William F.Durand	Leland Stanford University

*** Not available to authors

NACA headquarters were situated in the Navy building in Washington, D. C., close to the Army and Navy organizations. Information was made available to military and naval air organizations and other government branches, and unclassified information was released to university

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(20) 1. Extract, Third Annual Report, NACA, 7 Dec 17.

laboratories and aircraft manufacturers interested in the study of specific problems, and also to the public. This was accomplished by means of technical reports and notes in which the results of all important investigations and experimental research conducted by the committee were brought to the attention of aeronautical engineers; by technical memoranda, in which were the translated reports of the important investigations being conducted abroad; and by aircraft circulars in which were described the more important or more interesting new types of aircraft. These were all made available to aeronautical engineers and aircraft industry by bulletins released at regular intervals by the committee.[1]

On 2 March 1929, the membership of the committee was increased from the original 12 to 15.[2] The committee now consisted of two representatives of the Army Air Corps, two representatives of the Naval Air Corps, two representatives of the Civil Aeronautics Authority, one from the Smithsonian Institution, one from the United States Weather Bureau, one from the Bureau of Standards, and six additional members.

The importance of conducting aeronautical research was fully realized by European powers after World War I: there were undoubtedly more centers for aeronautical experimentation in Germany than there were in the United States.[3]

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(21) 1. "Research, The Price of Survival", G. W. Lewis, Director of Aeronautical Research, N.A.C.A., Western Flying, Sep 28, p.72.

(19) 2. "Aeronautical Research in the N.A.C.A.", S.Paul Johnston, Coordinator of Research, N.A.C.A. submitted to Aeronautics, 1940.

(22) 3. "Aeronautical Research and National Security", John F.Victory, Secretary N.A.C.A., National Aviation Forum, WN,20-21 Feb 39.

L.M.A.L. facilities and operations. The first building constructed for the NACA at the site which became Langley Field, was a building of modest dimensions, in which was established a small laboratory, an administrative office, and facilities for bedding and mess. The building was completed in 1918[1] and was first put to use by five employees of the committee.[2] This structure, together with a small hangar nearby, comprised the Langley Memorial Aeronautical Laboratory, the first field laboratory to be established for the NACA.[3]

Although ingenious and highly accurate instruments had been developed before 1918 to measure and record speeds, pressures, and the positions of control surfaces while an airplane was flying, flight tests could safely solve but few of the problems of aviation.[4]

In order to solve some of these problems experimentally, a five foot wind tunnel named the "atmospheric wind tunnel"[5] was begun and completed for the Langley Memorial Aeronautical laboratory in 1920. A wind tunnel was at that time the most important device for aeronautical research known to science. Instead of creating air flow over wing and tail surfaces by

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[1] History of Langley Field, by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. *MS.*

(23) [2] "Aeronautics Research", Edward R. Sharp, Chief, Administrative Division, NACA Lab., Langley Field, Va., *The Commonwealth*, Vol. II, No. 12, Dec 1935, p.8 .

[3] See Ch.1, "Background and Physical Plant."

(24) [4] "Faster, Safer Planes Developed in Biggest Wind Tunnels," Arthur Grahame, *Popular Mechanics*, Apr 34, p.27

[5] Converted to a 7" by 10" tunnel in 1930, according to Letta E. Dixon (now deceased), Secretary to CO and Adj., Langley Field, Va., 1928-1933.

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projecting a model through still air,[1] a model was held stationary on suitable balances or other measuring devices and a stream of air was made to flow around it. A plane actually flew while standing still, making possible accurate observations of its behavior. This gave an idea of how a full size airplane would behave in the air.[2]

When the first wind tunnel was laid out, the NACA recognized three problems of difference between laboratory and full-scale conditions. First there was that of the "Reynolds Number." Reynolds, a British physicist, had worked out the general relationships of such elements as model size, air speed, and air density, from which full-scale performance could be predicted by model tests. The "Reynolds Number" of any particular test was an indication of the scale on which it was run. The higher the number, the less was the uncertainty in applying correction factors. The number increased in proportion to the actual size and speed of the airplane tested.[3]

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(19) 1. Professor Samuel P. Langley first used the whirling arm device in the U.S. in the 1880's. His apparatus consisted of a counter-balanced beam 30 feet long, pivoted near one end and rotated in a horizontal plane by means of a steam engine. At the end of the arm traveling around the 60 foot circle, he was able to develop speeds up to 70 miles per hour. By mounting plates and airfoils of various sizes and shapes on the free end of the arm, he was able to develop some theories on air resistance of bodies, and mounted stuffed birds on the end of the arm to try to discover something of their aerodynamic characteristics. "Aeronautical Research and the N.A.C.A.," S.Paul Johnston, Coordinator of Research, N.A.C.A., submitted to Aeronautics, 1940.

(19) 2. "Aeronautical Research and the N.A.C.A.", S. Paul Johnston, Coordinator of Research, N.A.C.A., submitted to Aeronautics, 1940.

(19) 3. Ibid.

By 1920, the "Reynolds Number" had been raised to approximately 300,000 in the wind tunnel, as compared with the 60,000 of the pre-war years, but there was still a 20-to-one gap between the wind tunnel factors and the highest factors of stress encountered in flight. In the second place, there was the problem of building the model. In modeling complete airplanes, it was impractical to make a literal scale reproduction of every part, and it was necessary to guess at the total effect of all the model's omissions. Third, difficulties were already being encountered with the propeller-tip speeds in a range where compressability was becoming important, and the speeds were met with practically no resources except the largely empirical data of ballisticians.[1]

The variable density tunnel, completed on the field in 1922, was designed to provide results more truly representative of conditions on full-size airplanes in flight than had previously been obtainable in small-size tunnels operating a normal air pressure. When a model one-twentieth the size of the airplane was tested in this tunnel, there flowed over the wing of the model the same mass of air per second as would flow over the wings of the full size airplane in flight. Thus flight conditions were more accurately duplicated and the results were correspondingly more accurate. Wing shapes developed in this tunnel materially increased the speed range and carrying capacity of American airplanes.[2]

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(25) 1. Dr. E. A. Werner, Address, Dedication of 18' x 10' Pre Flight Wind Tunnel, 2 May 39.

(26) 2. "The Foundations of Air Progress," John F. Victory, Secretary N.A.C.A., National Aeronautic Magazine, Jan 1940.

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The next piece of large scale research equipment constructed by the NACA was the twenty-foot wind tunnel, completed in 1928, for investigating full-size propellers and the main parts of a full-size airplane.[1] In this wind tunnel, the NACA cowling for radial air-cooled engines was evolved. This cowling, by reducing the drag of the engine, increased the airplane speed more than 15 per cent. Following this work, investigations in this tunnel revealed that an engine nacelle with cowling was most efficient when located directly ahead of the wing rather than above or below as was the former practice.[2]

In 1931, the NACA constructed its full-scale tunnel in which a small, full-size airplane complete with engine and propeller could be tested.[3] The air jet of this tunnel was 30 feet high and 60 feet wide. After an airplane had been designed incorporating fundamental data furnished by previous research in smaller wind tunnels, the forces of air acting on the complete airplane were measured in this tunnel and the results were analyzed with a view to increasing further the efficiency of the complete airplane.[4]

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1. History of Langley Field, by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

(26) 2. "The Foundations of Air Progress", John F. Victory, Secretary, N.A.C.A., National Aeronautic Magazine, Jan 1940.

3. History of Langley Field by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS .

(26) 4. "The Foundations of Air Progress", John F. Victory, Secretary, N.A.C.A., National Aeronautics Magazine, Jan 1940.

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In 1932, a flight research laboratory was completed for the Langley Memorial Aeronautical Laboratory.[1]

The eight-foot, high-speed wind tunnel completed in 1935 made air speeds in excess of 500 miles per hour available in the test section. Data from this wind tunnel showed the changes of shape necessary to maintain efficiency at high speeds and also the strength and stiffness of the wings necessary to avoid wing flutter and to maintain safety at high speeds.[2]

Conspicuous among the committee's outstanding researches were studies of the pressure distribution over the wings, fuselage, and tail surfaces of various types of military airplanes; an investigation of engine cowlings, resulting in the development of the NACA cowl; investigation of the location of engine and propeller with reference to the wings of an airplane; a study of the problem of ice formation on airplane wings; and an extensive program of investigation of fuel-injection engines, commonly known as Diesel engines, with a view to the production of data necessary for the design of high speed fuel oil engines for aircraft.[3]

The growth of the Langley Memorial Aeronautical Staff kept pace with the growth of the plant, with the exception of two or three years during the depression. In 1935, the staff numbered more than 300, drawn from more than

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1. History of Langley Field by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

(26) 2. "The Foundations of Air Progress", John F. Victory, National Aeronautics Magazine, Jan 1940.

(23) 3. "Aeronautics Research", Edward R. Sharp, Chief, Administrative Division, N.A.C.A. Lab., Langley Field, Va., The Commonwealth, Vol. II, No. 12, Dec 1935, p.8 .

36 of the states, and formed a group that was socially and economically important to the community of "The Peninsula." The value of NACA facilities on Langley Field in 1935 was close to five million dollars, and the pay roll totaled more than $750,000.[1]

Heavier-than-air Activities

Air corps tactical school. World War I took the airplane from sportsmen and scientists and introduced its limitless possibilities as a weapon to the world's armies. Its use in the 1914 to 1918 struggle, necessarily limited, emphasized the need for an efficient school system to train pilots, mechanics, and officers for staff work and the command of tactical units. The United States Secretary of War authorized the establishment at Langley Field of the first such school in July 1920.[2]

The school began operation as the Air Service Field Officers School[3] on 30 October 1920. It was renamed the Air Service Tactical School in 1922; and, when the Air Service was reorganized and renamed the Air Corps, the name became Air Corps Tactical School. Its mission remained the same through all revisions: to train student officers to command and direct units in the air, to cooperate closely with other branches of the Army, and

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(23)1."Aeronautics Research", Edward R. Sharp, Chief, Administrative Division, N.A.C.A.,Lab, Langley Field, Va., The Commonwealth, Vol. II, No. 12, Dec 1935, p.8

2. History of Langley Field by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

3. Extracts, History of Air Corps Tactical School and Library, by Geraldine V. Carlisle, Librarian Maxwell Field, Ala. History filed in base historical office, Langley Field, Va.

to give students sufficient technical instruction to enable them to direct properly technical staff officers.[1] It was at this school that a sound tactical doctrine for the Air Corps originated.

A commandant headed the school, and an officer in charge of training supervised the program. Major William N. Hensley was the first commandant;[2] Major Thomas DeWitt Milling was the first officer in charge of training.[3] The 1920 to 1921 staff was completed with three directors, a school adjutant, a lecturer, and two instructors.[4] This staff, under the direction of Major Milling, organized the school and outlined the course of study.

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[1] History of Langley Field by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

[2] The school commandants were the commanding officers of Langley Field. Major Hensley served from 1920 to 1921. He was followed by Lt. Col. Charles H. Danforth, 1921 to 1924, Major Charles Westover, 1924 to 1926, Lt. Col. C. C. Culver, 1926 to 1929, Lt. Col. J.W.S. Wuest, 1929 to 1930, and Lt. Col. R.C. Kirtland, 1930 to 1931. History of Langley Field by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

[3] Only two men supervised the training while the school existed at Langley Field. Major Milling was in charge from 1920 to 1926; Major E. L. Naiden had control from 1926 to 1931. History of Langley Field by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

[4] The first staff: Major Frederick L. Martin, AS, Director; Major Davenport Johnson, AS, Director; Capt Joseph T. McNarney, Director; Capt. Gerald E. Brower, AS, School Adj.; Capt. John H. Jouett, AS, Lecturer; Capt. Clearton H. Reynolds, AS, Instructor; and 1st Lt. Ralph B. Bagby, AS, Instructor. History of Langley Field by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

Course subjects were selected for their value in developing students into competent commanders and staff officers of air units, up to and including an air brigade and an Army air service. The course aimed to teach officers the tactics and techniques of other Army branches for essential cooperation; to give them sufficient knowledge of naval craft and tactics to lead efficiently air attacks against fleets in cooperation with coast defenses; and to teach students the basic operational principles of technical equipment so they could properly direct technical staff officers.[1]

The school was divided into three departments: tactical, technical, and administrative. Subjects were placed in the different departments as shown in Table IV.[2]

No flying instruction was included in the course because all students were rated pilots. The training staff soon discovered that if air problems were to be safely and efficiently carried out, a refresher course in solo flying and a thorough course in formation flying were necessary for the school. This was accomplished during the 1922 to 1923 term.[3]

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[1] History of Langley Field by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

[2] Ibid.

[3] Ibid.

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Dirigible Landing at Hangar
Langley Field, Virginia
1927

10.11 Fort Monroe—10-23-44—10,000

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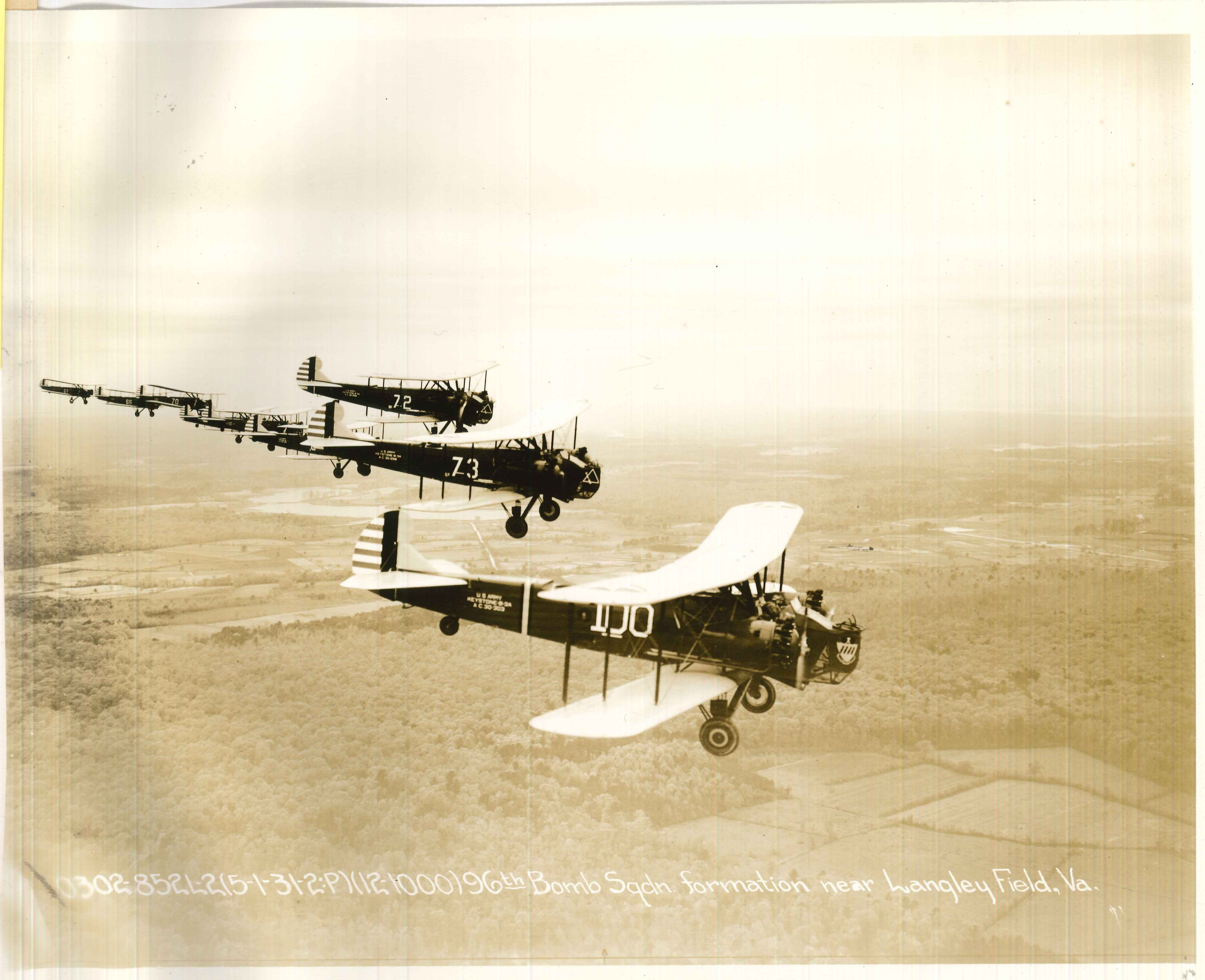
Ninety-Sixth Bombardment Squadron Formation,

Langley Field, Virginia, 1931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U.S. ARMY
KEYSTONE B-3A
A.C. 30-303

0302-8521-2(5-1-31-2:P)(12:1000) 96th Bomb Sqdn. formation near Langley Field, Va.

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TABLE IV. DEPARTMENTS AND SUBJECTS, AIR CORPS TACTICAL SCHOOL, LANGLEY FIELD, VIRGINIA, AS DEVISED IN OCTOBER 1920.

Department	Course
Tactical	Aerial Tactics -- Observation
	Aerial Tactics -- Pursuit
	Aerial Tactics -- Bombardment
	Aerial Tactics -- Attack
	Troops in Campaign
	Tactics and Staff Duties
Technical	Navigation and Meteorology
	Communications
	Photography
	Armament
	Engineering
Administrative	History of Air Service
	Army Regulations
	Hygiene and Sanitation
	Field Service Regulations
	Law

In 1922, the school was made available to all Air Service officers and the curriculum was broadened to include the tactical use of all branches of aviation. The revised course, based on the Command and General Staff School text, included combat orders, staff duties, supply and logistics, signal communications, engineering, and anti-aircraft artillery.[1]

Trips were made in 1923 for the purpose of introducing and familiarizing students with various types of Air Service work. Students witnessed an anti-aircraft demonstration at nearby Fort Monroe, Virginia; visited the aircraft carrier "Langley," toured the Ordnance Proving Ground at Aberdeen, Maryland, the Chemical Warfare Arsenal at Edgewood, Maryland, the Air Corps Engineering Division at McCook Field, Dayton, Ohio, and the base of the First Pursuit Group at Selfridge Field, near Detroit, Michigan. These trips were considered valuable enough to the course to be included as regular parts of the program.[1]

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[1] History of Langley Field by Letta E. Dixon and Lydia Gordon secretaries to the Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

The 1923 to 1924 class was the first to take part in the Army War College command post exercises. This practice was continued in the following years.[2]

Curriculum changes were again made in May 1925. Purely technical subjects such as photography, armament, airplane and airship engineering, meteorology, and aerial navigation were eliminated. The entire course was henceforth concentrated on tactics.[3]

In the spring of 1921, the War Department approved the formation of a Provisional Air Brigade for the purpose of conducting bombing experiments against ex-German warships. The Air Corps Tactical School instructors and students were used in staff and command capacities in the brigade. Brigadier General William Mitchell commanded the brigade's training and the bombing maneuvers which were held 60 miles off the cape Charles coast in July 1921.[4]

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1. History of Langley Field by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. *MS.*

2. *Ibid.*

3. *Ibid.*

4. Extract, *New York Times*, 14 Jul 21.
(27) Extract, *New York Times*, 19 Jul 21
(28) " " " " , 22 Jul 21.

Instructional methods used were lectures, tactical rides, map problems, aerial maneuvers, war games, ground and liaison maneuvers, and exercises with troops.

The chief problem confronting the school heads for several years following inception of the school was the scarcity of competent instructors. New instructors were not assigned in time to permit their working with experienced instructors before beginning their work. The term of 1923 to 1924 was the first in which instructors did not have additional summer duties and could devote their time to revising and coordinating the courses. It was also the first year in which texts were prepared. The 1926 staff was the first to include an instructor assigned from another Army branch.[2]

Eleven classes graduated while the school was stationed at Langley Field.[3] Table V shows the total number of graduates for each class, as well as the number of foreign, Air Corps, and other service officers graduating each year.[4]

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1. History of Langley Field by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. *MS*.

2. *Ibid*.

(29) 3. Among the students later to become generals in World War II were Claire L. Chennault, Jacob E. Fichel, Shepler W. Fitz-Gerald, G.C.Kenny, Arnold N. Krogstad, Frederick L. Martin, Albert L. Sneed, Carl Spaatz, and Barton K. Yount. See List of Graduates, 1921 to 1931. Air Corps Technical School, Langley Field, Va.

(29) 4. List of Graduates, 1921 to 1931, Air Corps Technical School, Langley Field, Va.

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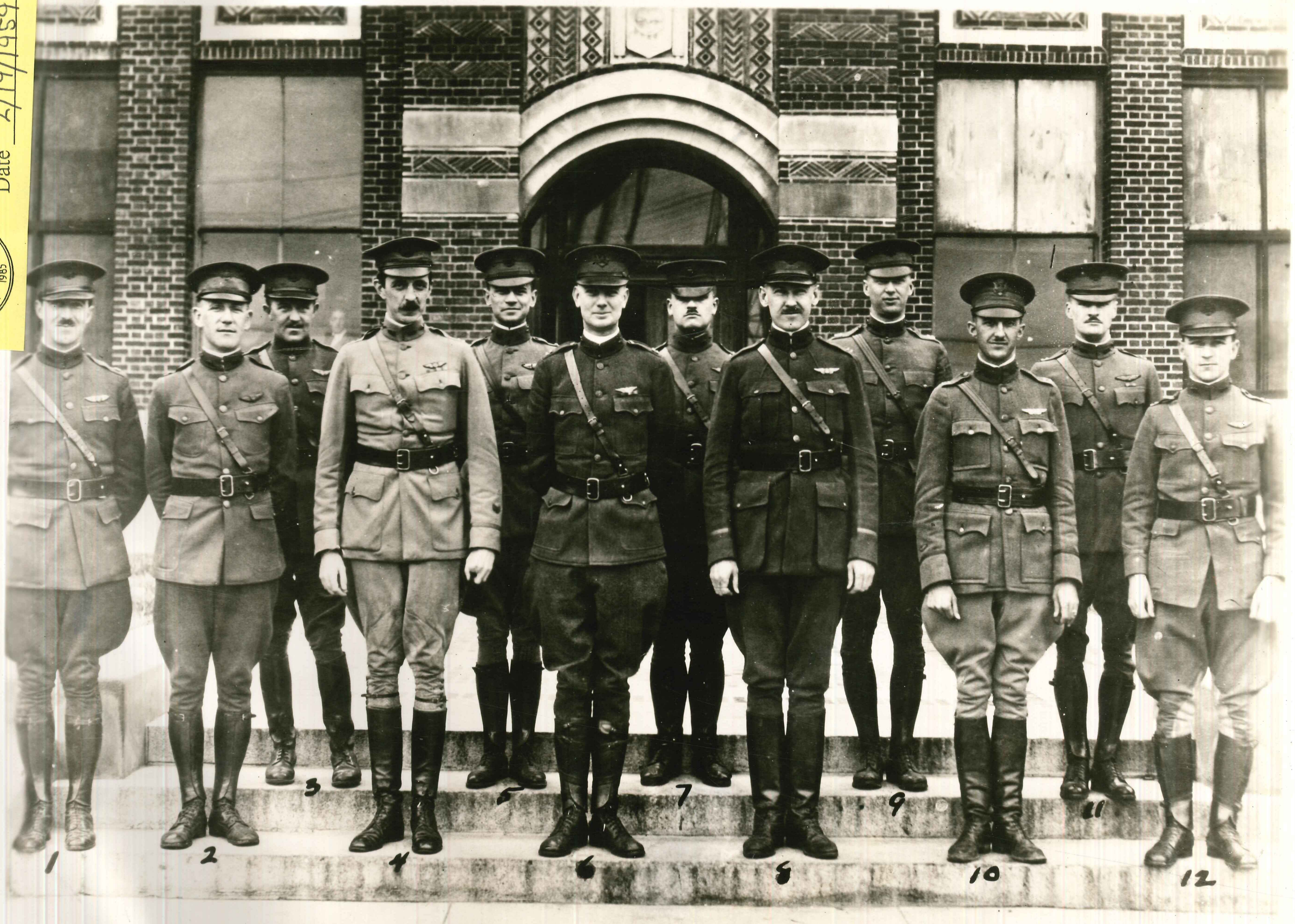
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Field Officers School - Class 1921-22

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TABLE V. TOTAL NUMBER OF GRADUATES, NUMBER OF FOREIGN, AIR CORPS, AND OTHER SERVICE UNITS GRADUATES, AIR CORPS TACTICAL SCHOOL, LANGLEY FIELD, VIRGINIA, BY CLASSES, 1921 TO 1931.

Class	Foreign Grads.	Other Service Grads.	Air Corps Grads.	Total Grads.
1920-1921	0	0	11	11
1921-1922	0	1	11	12
1922-1923	0	0	17	17
1923-1924	0	1	13	14
1924-1925	0	0	14	14
1925-1926	1	2	13	16
1926-1927	2	8	10	20
1927-1928	2	9	13	24
1929-1930	2	12	16	30
1930-1931	2	11	24	37
Totals	9	42	142	195

Crowded conditions at Langley Field in the early 1930s made necessary the selection of another field where the school could expand according to its needs. Through the efforts of Mr. Lister Hill, Congressman from Alabama, a site now known as Maxwell Field became the home of the Air Corps Tactical School on 1 July 1931.[1]

The bomber and the battleship. The Air Service early in 1921 set out to ascertain the effectiveness of aerial bombardment as a threat to the navies of the world. Bombs were dropped from aircraft upon some German ships, captured in World War I, which were moored in the Chesapeake

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[1] Extracts, History of the Air Corps Tactical School and Library, by Geraldine V. Carlisle, Librarian, Maxwell Field, Ala. Filed in base historical office, Langley Field, Va.

Brig. Gen. William Mitchel

Prophet of Air Power

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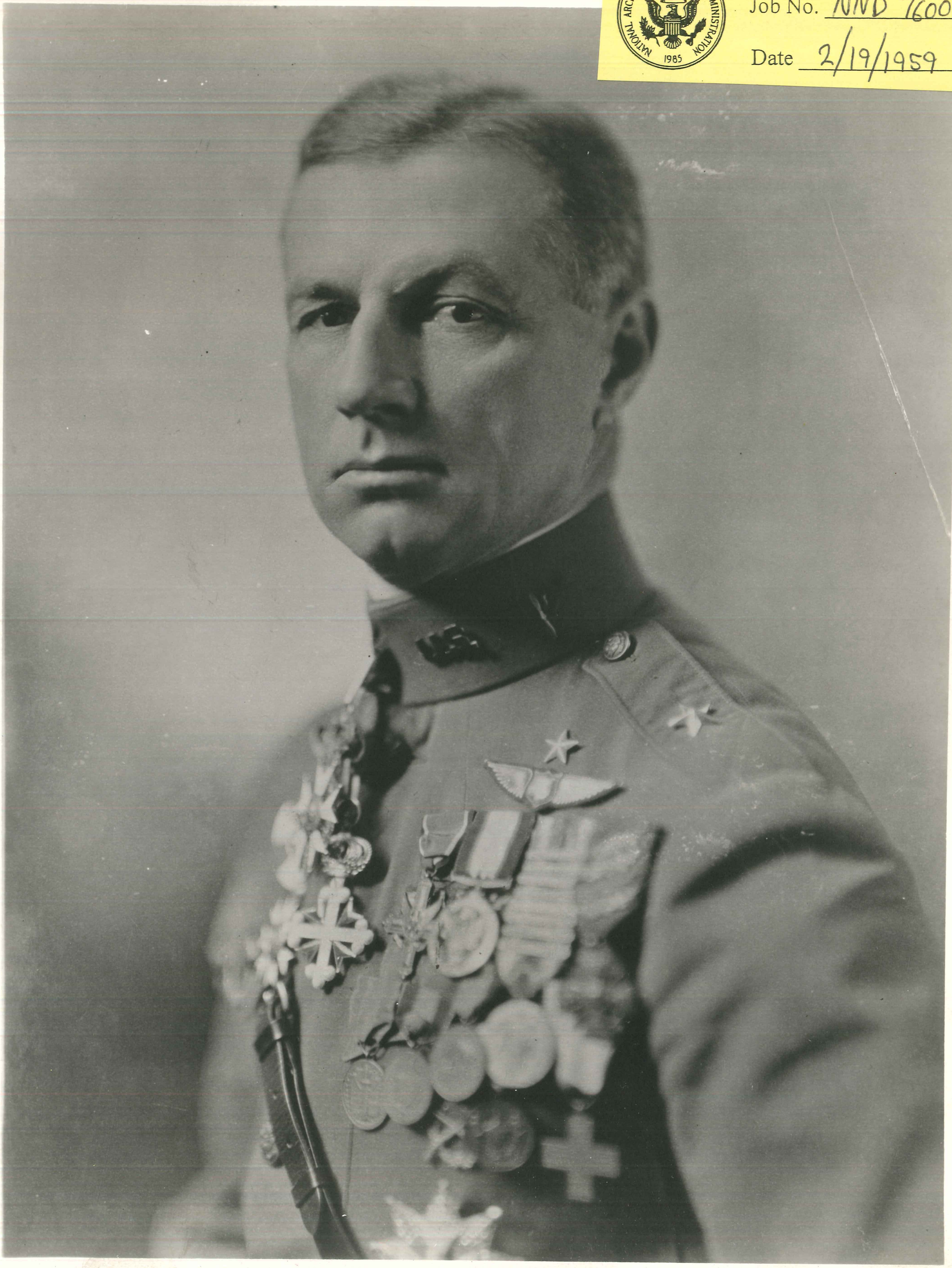

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Early Martin Bombers

Langley Field, Virginia

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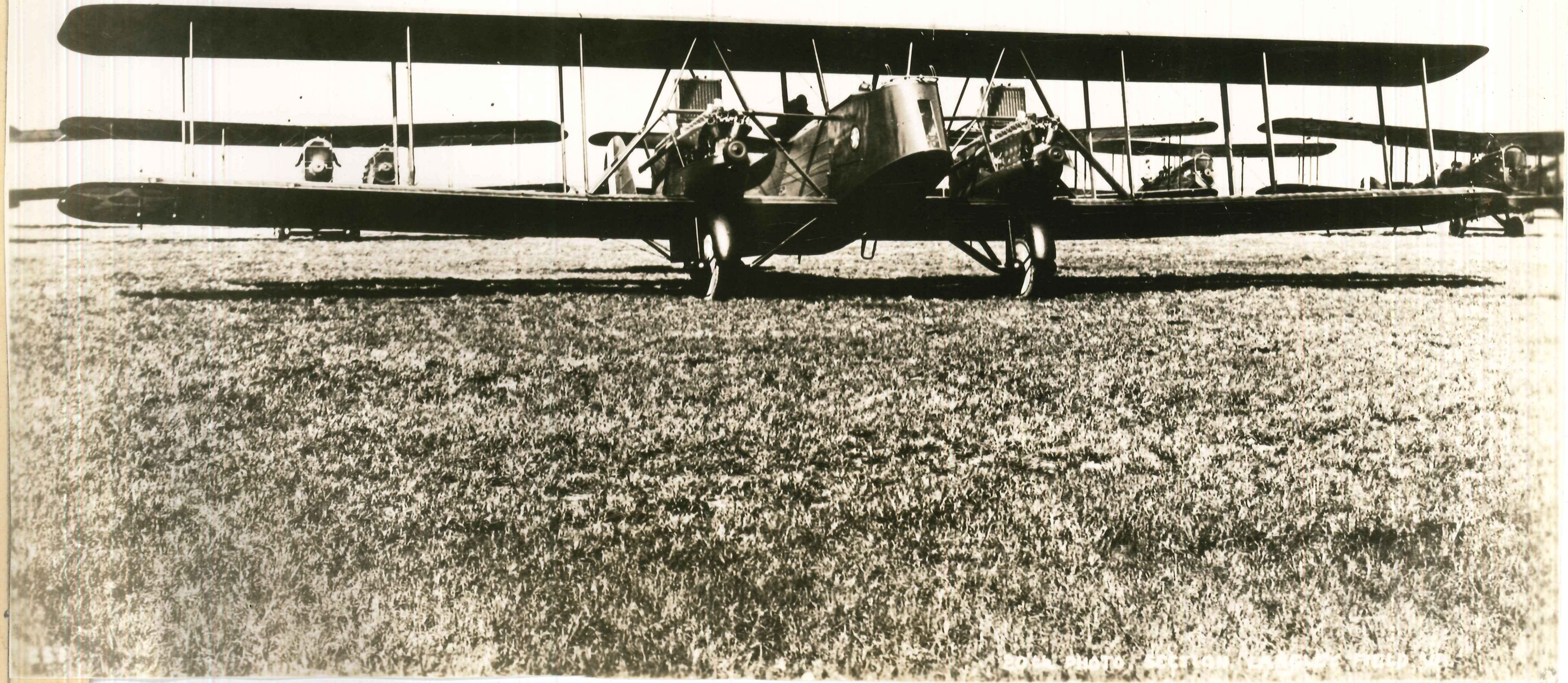
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20th PHOTO. SECTION LANGLEY FIELD VA.

Bay off the Cape Charles, Virginia coast. In command of the experiment was Brigadier General William Mitchell, who contended that the results of the experiment automatically made obsolete many fighting vessels of the Navy. The Navy actively resented his contentions, particularly when he advocated that a large scale construction of bombers should begin and the production of "obsolete" ships cease.

In preparation for the experiment, several aero squadrons (bombardment, photo, and observation), formed a Provisional Air Brigade at Langley Field, Virginia, and trained for participation in the bombing exercises. Instructors and students of the Air Service Field Officers School, all experienced flying officers, were used in staff and command positions in the brigade. The training of the organization was personally supervised and directed by General Mitchell, as were the subsequent maneuvers off the coast of Cape Charles.

The first target for the combined bombing forces was the German destroyer, G-102, moored about 60 miles from Cape Charles, Virginia. Fifty Army planes and three Army blimps took off from Langley Field and seven Navy planes left from Hampton Roads for the bombing mission on 13 July 1921. Each plane flew approximately 200 miles, since in the course of the bombing it was necessary for each to fly above the target for about one half hour.[1] The observation planes arrived first, followed by Sopwiths which strafed the destroyer with 25 pound Cooper bombs, theoretically intended to wound and drive from the deck the ship's personnel. A group

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[1] Extract, New York Times, 14 Jul 21.

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Airship TC-5

Langley Field, Virginia

1927

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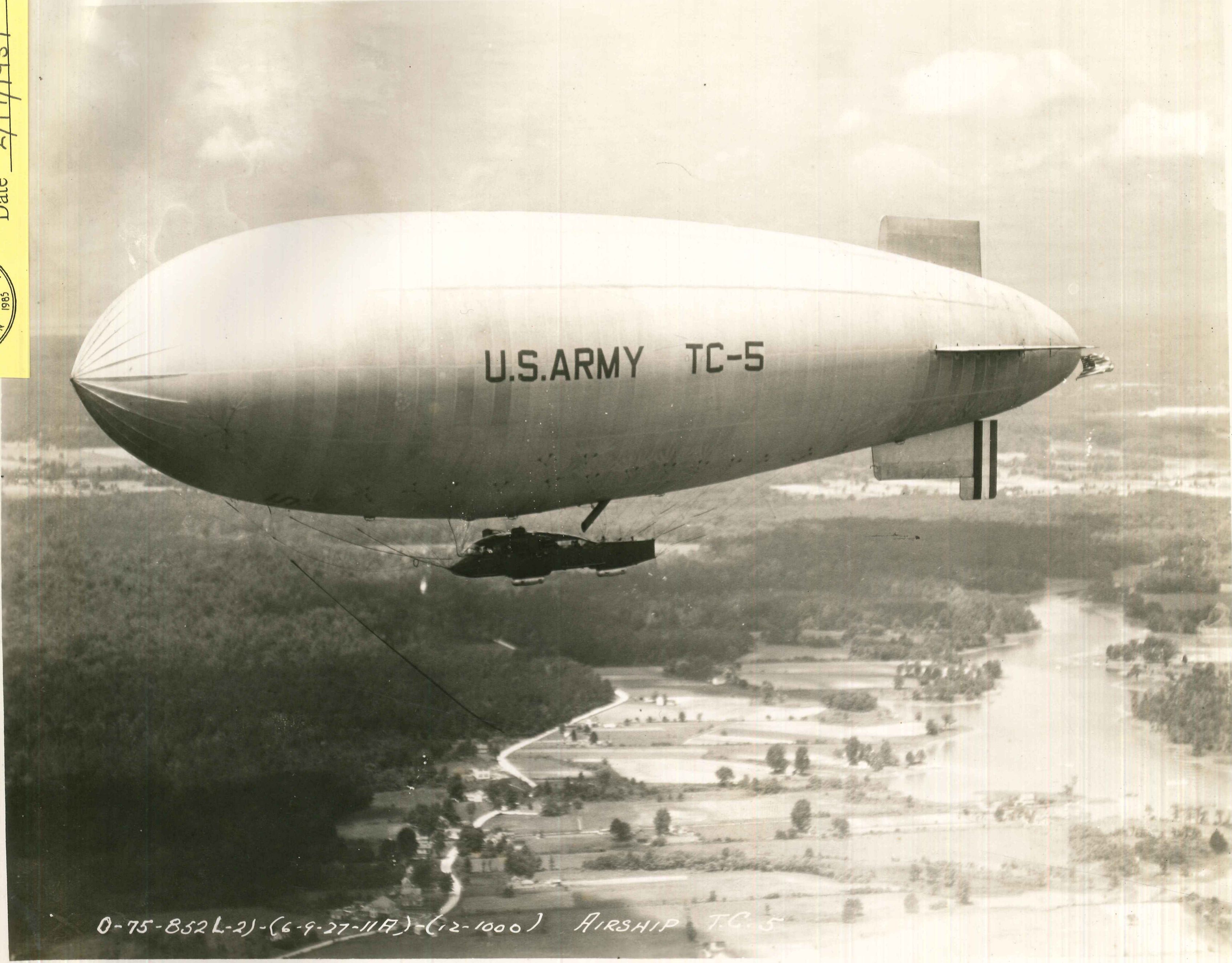

0-75-852(L-2)-(6-9-27-11A)-(12-1000) AIRSHIP T.C. 5

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of DH-4B's and four Martin bombers in "V" formation, loaded with 300 pound demolition bombs, then dropped their charges. Two bombs made direct hits and the G-102 sank.[1]

The ex-German cruiser, "Frankfurt", was bombed in a similar manner 18 July 1921. Although for three and one half hours the Army, Navy, and Marine Corps dropped bombs weighing up to 300 pounds in weight, the hull of the ship remained intact. A group of Martin bombers from Langley Field then arrived and dropped 600 pound bombs. The ship's deck was struck by two bombs, and a third exploded alongside. The "Frankfurt" was sunk ten minutes after the arrival of the Martin bombers with their 600 pound bombs.[2]

The dreadnaught, "Ostfriesland", was sunk on 21 July 1921, by 2,000 pound bombs dropped by Martin and Handley-Paige bombers. Some of the bombs landed near the ship, blew open its seams, and sank it in 25 minutes. At that time, the 2,000 pound explosive was the heaviest ever delivered against a battleship. The biggest mine hitherto used had weighed 500 pounds; the biggest torpedo, 500 pounds; the heaviest depth charge, 300 pounds; the biggest charge ever fired from a big gun at that time was 1,800 pounds, fired from the Gathman experimental gun. But this event demonstrated that a 2,000 pound explosive could be dropped alongside a battleship after having been carried 100 miles from the airplane's base out to sea.[3] A new precedent had been set.

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[1] Extract, New York Times, 14 Jul 21.

(27) [2] Extract, New York Times, 19 Jul 21.

(28) [3] Extract, New York Times, 22 Jul 21.

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Bombing of U. S. S. "Virginia"
off Cape Charles, Virginia
1923

10.11 Fort Monroe—10-23-44—10,000

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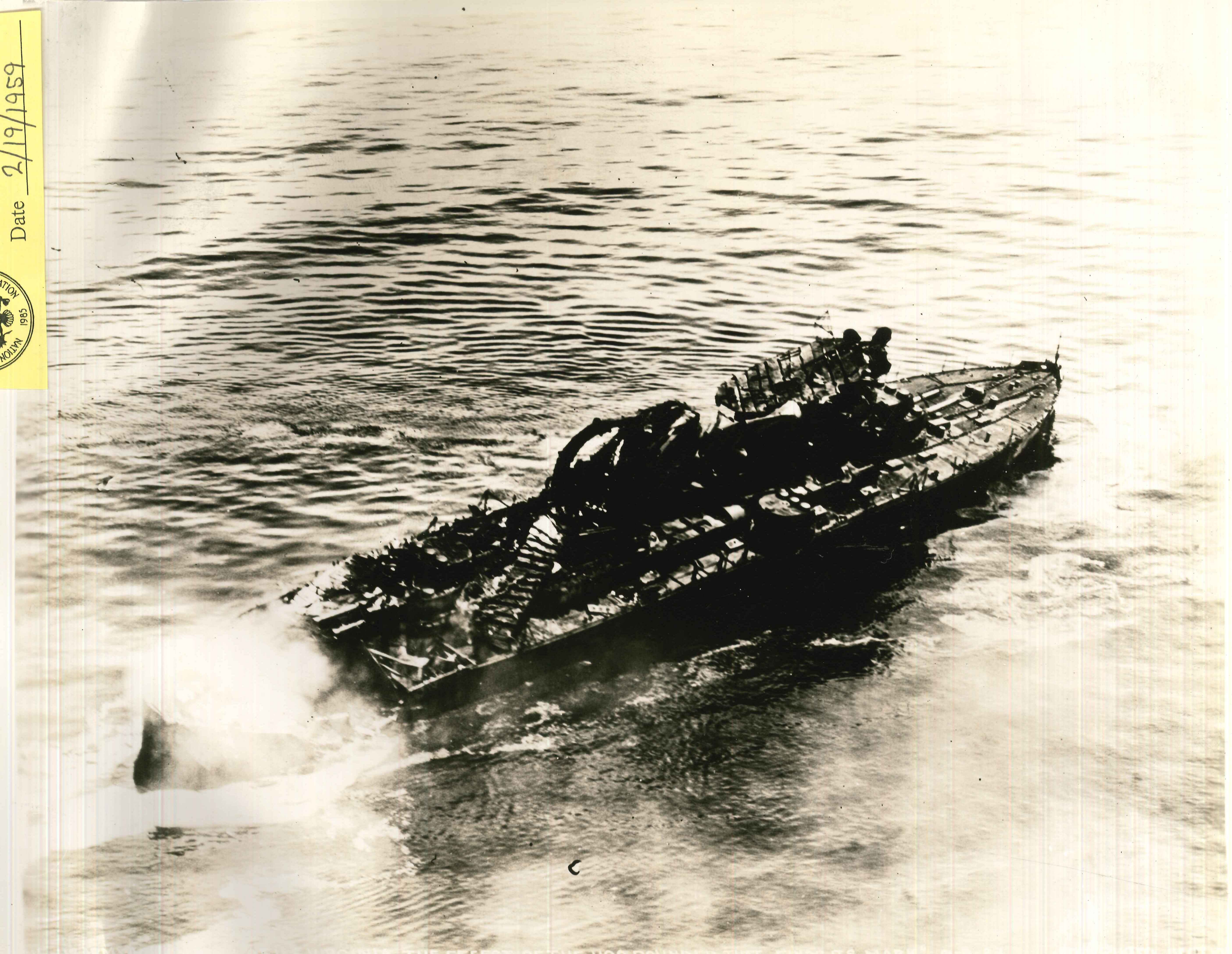

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Experimental bombing of the same kind was effected on the same site against the battleships, "Virginia" and "New Jersey" in September 1923. For the purposes of the experiment, a temporary airdrome had been established at Cape Hatteras, North Carolina in August 1923. Bombings were begun on 5 September. The "Virginia" was sunk with 1,100 pound bombs in 30 minutes; the "New Jersey", first attacked unsuccessfully from an altitude of 10,000 feet, was sunk when bombed at closer range. The Navy claimed that the bombings proved nothing, since the ships bombed were obsolete. General William Mitchell, who was also in charge of these experiments, had proved, nevertheless, that the bomb was the most disastrous weapon yet devised as a threat to the battleship.

Miscellaneous Army activities. From 1923 to 1929, Langley Field was the scene of the Annual Machine Gun and Bombing Matches. Originally held in October of each year, they were shifted to May in 1926, and were held thereafter in May and June.[1]

The First Class of the United States Military Academy was given special instruction at Langley Field in both 1928 and 1929. The classes were divided into three sections, and each section spent approximately six days at Langley Field, Fort Monroe, and Fort Eustis, Virginia. To assist Langley Field instructors, additional instructors were brought from Brooks Field,

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[1] History of Langley Field, by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

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Bombing of Pee Dee River Bridge

North Carolina

1927

10.11 Fort Monroe—10-23-44—10,000

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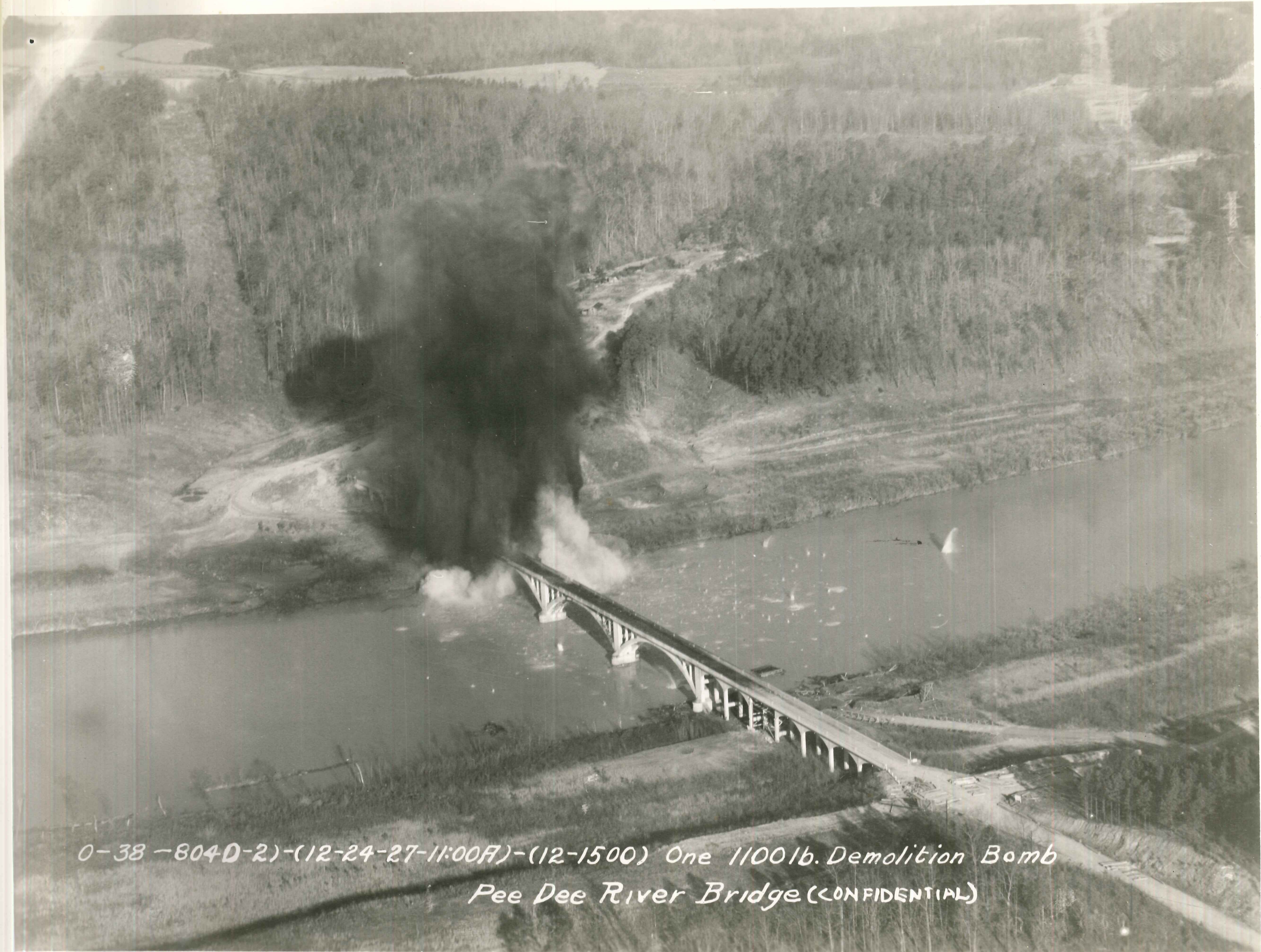

0-38-804D-2)-(12-24-27-11:00A)-(12-1500) One 1100lb. Demolition Bomb
Pee Dee River Bridge (CONFIDENTIAL)

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San Antonio, Texas.[1]

The Second Bombardment Group made flights to different parts of the United States during the years 1923 through 1935. On 23 August 1923, the group flew to Bangor, Maine, and returned on 24 August. In August of 1929, the group flew cross-country to San Diego, California, and returned after a lapse of thirteen days.[2]

On 13 September 1928, nine planes from the Second Bombardment Group participated in the air races at Los Angeles.[3]

A special maneuver by the group was the bombing of the Pee Dee Bridge, North Carolina. The maneuver was successfully completed in December 1927.[4]

Joint antiaircraft-aircraft exercises were held at Langley Field from 1 to 3 May 1929. Battery "E" of the 61st Coast Artillery, Fort Monroe, joined with air organizations of the field to make the exercises successful.[5]

Lighter-than-air Activities

The first balloon detachment at Langley Field was formed on 15 June 1918.[6] A balloon hangar for the activities of this organization was

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[1] History of Langley Field, by Letta E. Dixon and Lydia Gordon, secretaries to Commanding Officers, Langley Field, Va., 1928 to 1936. MS.

[2] Ibid.

[3] Ibid.

[4] Ibid.

[5] Ibid.

[6] Report Sheet. Report of Sick and Wounded at Post Hospital, Langley Field, Va., Jun 1918.

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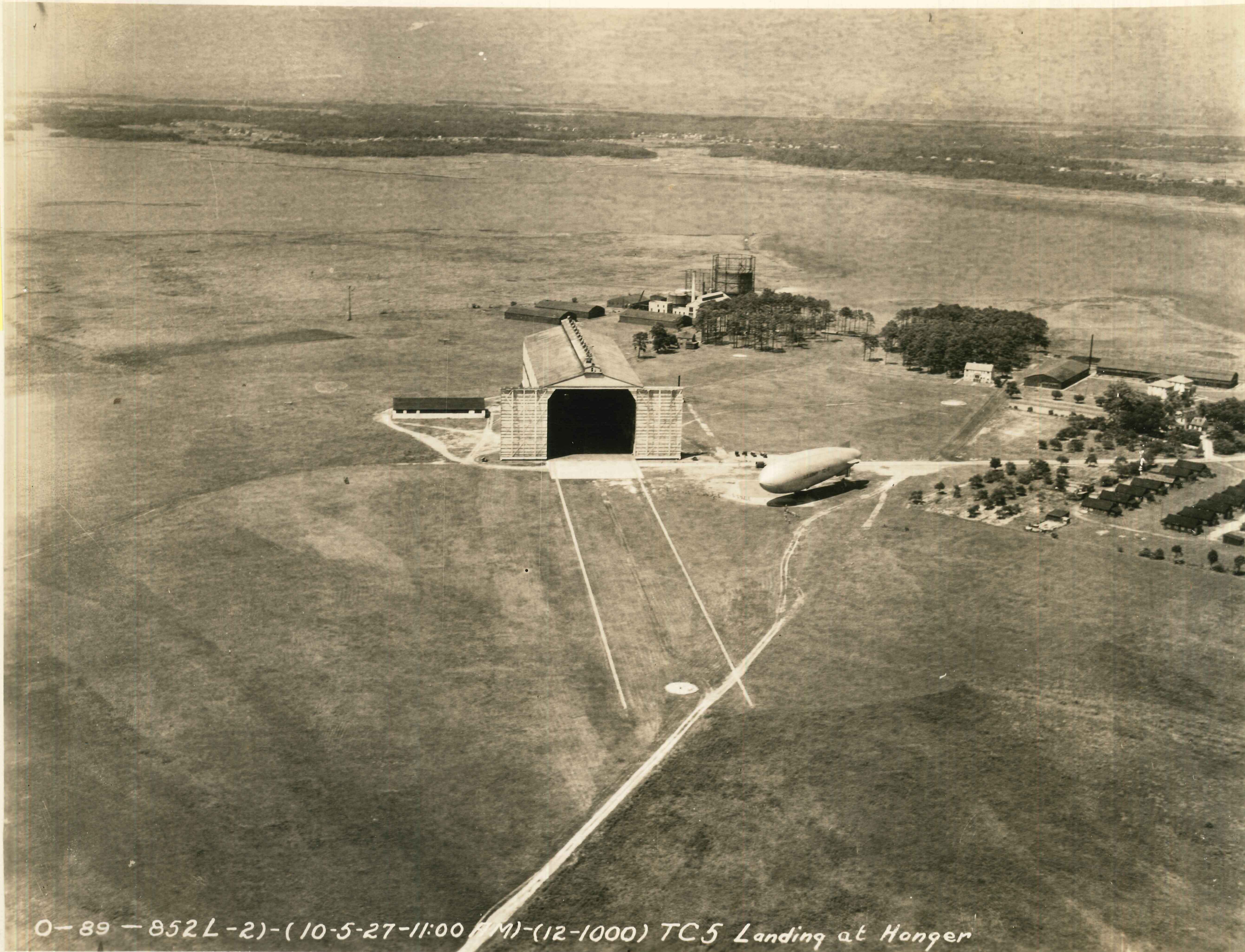

0-89 — 852L-2)-(10-5-27-11:00 AM)-(12-1000) TC5 Landing at Honger

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completed by the end of 1919.

Several balloon companies were sent to Langley Field at the close of World War I for temporary quartering until disbandment. The 61st and the 71st Balloon Companies were ordered to Langley Field on 3 March 1919. The 61st Company was disbanded in April and the 71st in May of 1919. A Balloon Wing, A.E.F., arrived and immediately was disbanded in March 1919.

On 25 March 1919, the 12th and 34th Balloon Companies reported to the field, the 12th being disbanded at once, while the 34th was almost entirely demobilized. The latter company later absorbed the personnel of the disbanded 71st Company, and again reached full strength. The 59th Balloon Company was sent to Langley Field in July 1919 and was disbanded immediately.

On 24 July 1919, the 19th Balloon Company was assigned to the field. This company was destined to become a fixture there. Organized at Fort Omaha, Nebraska, 24 January 1918, the company was sent to France, 3 November 1918. It was stationed with the United States Balloon School, Camp DeSouge, France, until February 1919, when it was ordered back to the United States. On arrival at Mitchel Field, 19 April 1919, it was demobilized. The company was reorganized at Langley Field on 24 July 1919.

The 28th Balloon Company came to the field on 7 August 1919, and the 29th Balloon Company arrived 11 August 1919. Both organizations were disbanded on 8 October 1919.

The 10th Balloon Company was assigned to Langley Field on 22 September 1919. In March 1920, the 26th Balloon Company was sent to Langley Field.

It was disbanded in May 1920. This action left the 10th and the 19th Balloon Companies as the only two remaining lighter-than-air units on the field. Both units were redesignated the 10th and 19th Airship Companies on 18 April 1920. The 10th Airship Company was again redesignated 1 October 1921, when it became the "Airship School". As such, the organization was transferred to Scott Field, Illinois, 30 June 1922.

Men of the 19th Airship Company went to Italy in 1921 for the "Roma", a semi-rigid, hydrogen-filled dirigible, 410 feet in length. It was constructed in Italy and sold to the United States Government for $200,000 in 1921.[1] Shipped dismantled to this country, the craft, once reassembled, was quartered in the lighter-than-air hangar at Langley Field and assigned to the 19th "Airship Company.

Four Italian-built motors gave the airship a speed of only 40 miles an hour and were, for that reason, judged unsatisfactory. Four new American-made "Liberty" engines gave the dirigible increased speed and power. One factor, however, was not considered. Air pressure upon the tubular, metal nose of the craft at a speed of 40 miles per hour was approximately 1,600 pounds, whereas at a speed of 60 miles per hour, air pressure was almost doubled. No reinforcement was given the nose to prepare it for increased air pressure.[2]

On 21 February 1922, a crew of 44 Langley Field airmen took the "Roma" aloft for the initial testing of the new "Liberty" engines. The craft, gaining momentum, moved in the direction of Willoughby Point, its speed climbing slowly past the maximum hitherto attained. Suddenly the top of the nose began pushing into the bag, its original supports apparently having given way. The nose then became a rudder which plunged the airship on a downward course through some 2,200 volt high tension wires and on to the ground, where it folded like an accordian. Gasoline from the engines ignited and spread through the wreckage.[1]

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[1] Extract, Daily Press, Newport News, Va., 21 Feb 41.

[2] Interview (typescript), Starr Truscott, Chief of Hydrodynamics Dept., N.A.C.A., Langley Field, Va., 9 Aug 44.

When the dirigible crashed, M/Sgt. Harry A. Chapman quickly grabbed a sharp instrument, cut through the bag of the craft which had covered the crew, and aided eight men to escape through the opening as flames covered them all.[2] Thirty-four of the crew perished. Burned badly about the face, head, and body as a result of his rescue efforts, Sergeant Chapman spent several months in the Walter Reed Hospital in Washington. He was later awarded the Congressional Medal of Honor and the Cheyney Award.

After the "Roma" crash, the 19th Company reverted, in accordance with Air Corps policy, to the non-rigid ball-shaped type of balloon. The company's mission was now concerned only with observation.

Lighter-than-air activities at Langley Field ceased with the transfer, a permanent change of station, of the 19th Airship Company (redesignated "squadron" in October 1935) to Sunnyvale, California, in November 1935.

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1. Interview (typescript), Starr Truscott, Chief of Hydrodynamics Dept., N.A.C.A., Langley Field, Va., 9 Aug 44.

2. Extract, Daily Press, Newport News, Va., 22 Apr 40.

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P-1-B Pursuit Plane
Langley Field, Virginia
1929

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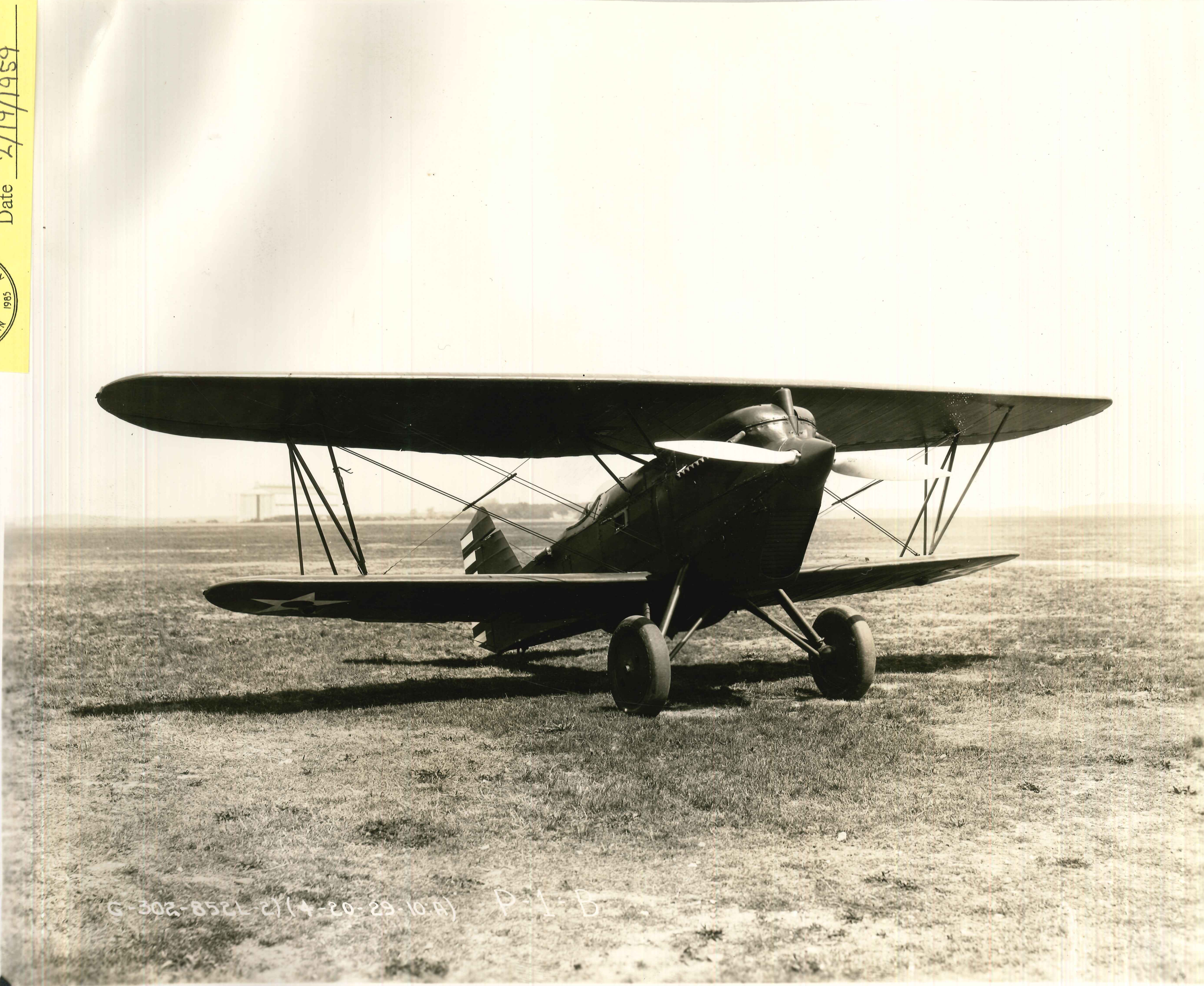

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Summary

The Smithsonian Institution, under the leadership of Dr. Charles Walcott, carried forward the experimental work of Samuel Pierpont Langley, a former secretary of the Institution. Dr. Walcott's efforts eventually were supported by the wartime interests of the United States, and as a result the National Advisory Committee for Aeronautics was established by law on 3 March 1915.

When the time came to build an experimental laboratory for the NACA, a cooperative experimental station and proving ground was suggested, to be used jointly by the NACA, the Army, and the Navy. Considerations such as the defense of the eastern seaboard; nearness to Washington and the manufacturing centers of the East; the presence of terrain that could be converted into bases for both land planes and seaplanes; and the business acumen of a Hampton, Virginia, citizens' committee -- all these influenced the Government's site board, headed by Lieutenant Colonel George O. Squier, to select the site that became Langley Field.

The deed to the first tract of land acquired for the experimental station was dated 30 December 1916, and the military installation was designated Langley Field on 7 August 1917.

Slow, elaborate construction work compelled the Army and the Navy to build experimental proving grounds for aircraft elsewhere. Only the NACA was able to move onto the field according to plan, and its tenure was uninterrupted, although meager appropriations from Congress ($5,000 a year for several years) greatly restricted experimental activities.

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The part of Langley Field not devoted to NACA projects became progressively more important as an air base for the Aviation Section of the Signal Corps, particularly after the end of World War I, and the field quartered many famous squadrons. The air base was administered separately from the NACA's Langley Memorial Aeronautical Laboratory, which employed mostly civilians. Nevertheless, as the years passed, Army and NACA activities functioned side by side with a minimum of friction.

Perhaps the most spectacular work of the Langley Memorial Aeronautical Laboratory was done in its wind tunnels, where both nodels and full-scale planes were tested so that aircraft might fly faster and more safely.

The most-publicized experiments with which the Army was associated, along with the Navy, was the test-bombing of German warships, and later, the bombing of the old United States battleships "Virginia" and "New Jersey". General "Billy" Mitchel played a dominant role in these experiments, which wrote a page in the history of aviation that was later supplemented by the bloody page inscribed at Pearl Harbor on 7 December 1941.

The Air Service Tactical School was organized in November 1920, and operated at Langley Field until the summer of 1931 for the youthful air arm of the United States.

The crash of the dirigible "Roma" during a flight from its base on Langley Field in 1921 was one of several such incidents that caused the Army to de-emphasize use of lighter-than-air ships, and to concentrate on heavier-than-air types of aircraft.

Meantime, throughout the years 1916 to 1935, construction progressed on the field, and by 1 March 1935, the stage was set for the General Headquarters Air Corps to move onto Langley Field.

Chronology of Important Events

Langley Field, Virginia

1915 to 1935

3 March	1915	National Advisory Committee for Aeronautics established by Act of Congress.
30 December	1916	Date of deed for first land purchased for Langley Field.
	1918	First Building for NACA completed.
	1919	Original airship hangar completed.
June	1917	First contingent of military personnel arrived at Langley Field.
7 August	1917	Name "Langley Field" made official designation by War Department.
1 November	1920	Air Service Field Officers' School opened at Langley Field.
18, 21 July	1921	Experimental bombing of battleships conducted by Brigadier General William Mitchel.
22 February	1922	"Roma" dirigible disaster.
June	1922	Series of night cross-country flights between Bolling Field and Langley Field initiated by Lt. C. F. Bissell.
8 August	1922	Second Wing of Air Service organized.
14-23 September	1922	First transcontinental airship flight was made by the non-rigid C-2, Langley Field, Virginia, to Ross Field, Arcodia, California.
5 September	1923	Battleships bombed by planes in experiments conducted by Brigadier General William Mitchel.
8 February	1925	Tests made of glider targets for aerial machine gun practice.

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December	1927	Experimental bombing of Pee Dee River Bridge, N.C.
	1931	Largest Langley Field wind tunnel completed. At time of dedication, it was world's largest wind tunnel.
31 August	1931	Air Corps Tactical School moved to Maxwell Field, Alabama.

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CONFIDENTIAL

RESTRICTED

HISTORY
of
LANGLEY FIELD

LANGLEY FIELD, VIRGINIA

INCEPTION TO 1 MARCH 1935

FIRST PERIOD

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REGRADED
CONFIDENTIAL
TOP SECRET
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VOL II

APPENDIX

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10.11 Fort Monroe—12-4-44—60

APPENDIX

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LIST OF APPENDIX ITEMS

1. Authenticated Interview, John F. Victory, Secretary, NACA, 23 Aug 44.

2. (No file number) and two Incls., Lt. Col. George O. Squier, to: the Adjutant General, 4 Dec 16, subj: "Acquisition of Land for Aviation Purpose."

3. (No file number), Two letters, H. R. Booker, Nelson S. Groome, H. H. Holt, Hampton, Va., to: Capt. T. D. Milling, Recording Officer of Board of Officers, War Dept., Wash., D.C., 17 Nov 16 and 22 Nov 16.

4. Easement, (no file number), Paul Tabb, Hampton, Va., to: H. R. Booker, N. S. Groome, and H. H. Holt, Hampton, Va., 17 Nov 16.

5. Deed, H. R. Booker, et al, to the United States of America, 30 Dec 16 (verified 24 Feb 17). Recorded in Deed Book 60, p. 444, public records of Elizabeth City County, Va.

6. Map, Langley Field, compiled by tracings from maps of Elizabeth City County, Va.; compiled by J. L. B. Buck, 1917, and L. C. Lyman, 1908; and map dated Feb 1917 by Gerald Chambers.

7. (No file number), J. N. Shannahan, Pres., Newport News and Hampton Railway, Gas, and Electric Co., Hampton, Va., to: Messrs. Booker, Holt, and Groome, 8 Nov 16.

8. (No file Number), John Werth, Supt. of Construction, Langley Field, Va., to: Major C. T. Waring, Construction Division, Signal Corps, U.S.A., Langley Field, Va., 6 Dec 17.

9. 313.6 and Ind., Hq, Army Air Base, Langley Field, Va., to: the Adjutant General, Wash., D.C., 14 Feb 43, subj: "Disposition of Illegible Records."

10. Recapitulation of Costs, Langley Field Project, Hampton, Va., from combined accounts of Contractors and Government, Jun 17 to Mar 19.

11. CQ 615, War Dept., Office of the Constructing Quartermaster, Langley Field, Va., to: the Quartermaster, Langley Field, Va., 18 Jan 35, subj: "Completion Report."

12. Deed, F. W. Darling and wife, to: United States of America, 1 Sep 17. Recorded in Deed Book 37, p. 353, Public Records of the County of York, Va.

13. Extracts, History of Fort Eustis (Mulberry Island), Va., Office of the Adjutant, Fort Eustis, Va.

14. Map, Mulberry Island, Warwick County, Va., 27.

15. List of Commanding Officers, Langley Field, Va., Jul 17 to Mar 35.

16. Report of Sick and Wounded, Langley Field, Va., Oct 17.

17. Organizational Chart, Langley Field and 2nd Wing Air Corps, 23 Jul 28.

18. Memorandum, Hq, Langley Field, Va., 3 Jul 32.

19. "Aeronautical Research and the NACA", S. Paul Johnston, Coordinator of NACA, submitted to Aeronautics, 40.

20. Extract, Third Annual Report, NACA, 7 Dec 17.

21. "Research, The Price of Survival", G. W. Lewis, Director of Aeronautical Research, NACA, Western Flying, Sep 20.

22. "Aeronautical Research and National Security", John F. Victory, Secretary, NACA, National Aviation Forum, V IV, 20-21 Feb 39.

23. "Aeronautics Research", Edward R. Sharp, "The Commonwealth", Vol.II, No. 12, Dec 35.

24. "Faster, Safer Planes Developed in Biggest Wind Tunnels", Arthur Grahame, Popular Mechanics, April 34.

25. Dr. E. A. Werner, Address, Dedication of 18' x 10' Pre-Flight Wind Tunnel, 2 May 39.

26. "The Foundations of Air Progress", John F. Victory, Secretary, NACA, National Aeronautic Magazine, Jan 40.

27. Extract, New York Times, 19 Jul 21.

28. Extract, New York Times, 22 Jul 21.

29. List of Graduates, 21 to 31, Air Corps Tachnical School, Langley Field, Va.

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NACA - Langley

NOTES ON INTERVIEW HELD BY COPORAL ROBSON OF BASE HISTORICAL OFFICE WITH MR. VICTORY, SECRETARY OF NACA, ON AUGUST 23, 1944

Langley failed December 8, 1903; the Wrights succeeded nine days later. There had been no connection between their respective efforts; each was independent of the other. It's true that the Wrights had considered the Langley data but had found it to be erroneous and had discarded it. They had derived thier own original basic data from their own original research on lift and drag, derived from tests in their own wind tunnel. When Langley failed, the wreckage of his machine was wiped off and put away in his workshop in the Smithsonian Institution (not the National Museum). Langley died in 1906, it is said of a broken heart because of the public ridicule as a result of his failure. Langley had, in a series of experiments terminating in 1896, successfully flown quarter-size modles of his "aerodrome," as he called it. He retired in 1896, stating in effect that he had thus demonstrated the practicability of mechanical flight, and that it remained for others to carry on the work and to build a full-size man-carrying machine.

Then came the Spanish-American War in 1898. President McKinley was interested in building a full-size aerodrome and through his intercession an allotment of funds was made by the Board of Ordanance and Fortification of the War Department to the Smithsonian Institution in the amount of twenty-five thousand dollars, which was followed by
1 another allotment of the same amount. Langley in the late summer of

1903 failed in an attempt to launch his aerodrome from a catapult mounted on a houseboat in the Potomac River. It was reported that some mechanical gadget failed to operate properly. In the final unsuccessful attempt on December 8, 1903, it was reported that another and different gadget failed to function properly in the launching attempt. In neither attempt did the full-size aerdrome actually fly any distance whatever.

Dr. Charles D. Walcott succeeded Dr. Langley as Secretary of the Smithsonian Institution on Dr. Langley's death. About 1912 Dr. Walcott secured from the Board of Regents of the Smithsonian Institution favorable action on his proposal to re-open Langley's workshop and to operate it as the Langley Aerodynamical Laboratory. The work was to be directed by an Advisory Committee for Aeronautics to be established by the Smithsonian Institution. Such an advisory committee was established and did hold several meetings. It was, however, effectively put out of business by an adverse decision of the Comptroller of the Treasury, who held in effect that the Advisory Committee, not having been established by law, Government personnel and supplies, could not be employed in the prosecution of its work. Thereupon Dr. Walcott sought the enactment of legislation, but there was practically no interest in the Congress in the subject of aeronautics. When the world war broke in August 1914, Dr. Walcott renewed his efforts to secure legislation. It was then the policy of President Wilson to observe very strict neutrality, and he withheld assent on the ground that it would be an unneutral act. Dr. Walcott nevertheless carried the matter to the Congress and secured the enactment of legislation, which

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President Wilson approved on March 3, 1915, establishing by law the National Advisory Committee for Aeronautics.

Lt. Col. George O. Squier came back from England in May, 1916, and was placed in charge of the Aviation Section of the Signal Corps. He was immediately appointed a member of the NACA and was soon made Chief Signal Officer, with the rank of Major General.

The concept of Langley Field originated at meetings of the NACA in the summer of 1916. It was agreed that there should be a joint experimental field, and proving ground for aircraft, to be used by the Army, the Navy, and the NACA. The Signal Corps of the Army at that time had jurisdiction over Army aviation, through an organization known as the Aviation Section of the Signal Corps. It had money available, also, to buy land in what was then regarded as a "minificent" appropriation of fifteen million dollars for the Aviation Section. The Signal Corps agreed to finance the purchase and development of such a station. The Signal Corps appointed a board of officers to inspect sites; the Navy did likewise; each group traveled separately and as civilians, posing as hunters of fishermen. The NACA appointed a committee of three to consider the sites recommended by the Army and Navy groups respectively. The choice narrowed down to the sites now known as Aberdeen, Maryland, and Langley Field, Virginia, and the naval point of view prevailed in the selection of Langley Field, because it was contiguous to salt water and deep water.

The Army, in the development of what is now known as Langley Field, departed from its traditional custom in the building of a military station and secured the services of a distinguished civilian architect to lay out the proposed joint experimental field and proving ground. Albert Kahn of Detroit was the architect. General Squier's selection of Mr. Kahn is the chief reason for the departure of Langley Field from what was, up to that time, standard Army practice in the development of its stations.

When the joint experimental field and proving ground was laid out, plot 16, comprising about six acres, was assigned to the National Advisory Committee for Aeronautics. At various times during the summer and fall of 1917, Langley Field was described by General Squier as "the bottleneck of the aircraft program."

Langley Field was built under a "cost-plus" contract with the J. G. White Engineering Corporation of New York City. It was projected as a permanent station, which is evident from the quality of construction of the first buildings erected. The NACA contracted with the White Corporation to erect its "research laboratory," then comprising one building which became its administration building. In the meantime, work was progressing so slowly, due to the fine quality of the design of the buildings, that Colonel Edward A. Deeds, then Chief of the Bureau of Equipment of the Signal Corps, and one of three Army members of the Aircraft Production Board of which Howard E. Coffin was chairman, secured authority to establish a temporary experimental field at Dayton, Ohio. Such a field was hastily constructed and the original units made ready for use before any of the permanent buildings at Langley Field were finished. That Ohio field was known as McCook Field, which was later abandoned and its activities moved to the present

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Wright Field near Dayton. The first permanent building finished on Langley Field was the NACA "Research Laboratory" building on plot 16. The quarters built on Langley Field during World War I were not officers' quarters - they were built for civilians of the "Science and Research Division of the Signal Corps," which activity never got into operation at Langley Field. The original civilian and military staff of the NACA was first quartered in the NACA "Research Laboratory" building. They worked, slept, and ate in the one NACA building and later they were quartered in the married- and bachelor-officers' quarters of the Post.

The original purpose of Langley Field was to be a joint experimental field for aircraft for the Army, the Navy, and the NACA. Naval developments for World War I caused the Navy to withdraw from the joint plan and the Navy built the Hampton Roads Naval Air Station. The NACA continued under the original plan and has developed its great research laboratories known as the Langley Memorial Aeronautical Laboratory, comprising, up to the year 1944, more than fifty structures with a plant value of approximately twenty-six million dollars, and employing over three thousand persons. There has hardly been a year when the NACA was not building some new research facility.

JOHN F. VICTORY
Secretary, NACA

RESTRICTED

W.D., Office of the Chief Signal Officer,
Washington, December 4, 1916.

From Lieut.-Col. George O. Squier, S.C., President of the Board Convened as per Special Orders No. 216, c.s.
To The Adjutant General of the Army (through the Chief Signal Officer).
Subject: Acquisition of land for aviation purposes.

1. Herewith is a recommendation of the Board appointed by S.O. No. 216, W.C., c.s., for the acquisition of land for aviation purposes, which has been approved by the Secretary of War. Appendix B, hereunto attached, is the agreement under which it is desired to purchase the land. Other papers and maps relating to the tract of land in question are also attached.

2. It is requested that the Quartermaster General be directed to purchase the land.

3. Under the provisions of the Army Appropriation Act, Signal Service of the Army, 1917, as follows:

> "The Secretary of War is directed to investigate the suitability of the various military reservations for aviation purposes, and should any of the reservations be found not suitable and not available for aviation he is authorized, in his discretion, to acquire, by purchase, condemnation, or otherwise, for the United States of America, such land as may be necessary for aviation purposes, and there is hereby appropriated, out of any money in the Treasury not otherwise appropriated, the sum of $300,000, or so much thereof as may be necessary, for said purpose."

it is recommended that $290,000 be allotted for this purpose and the transfer of this amount from appropriation, Signal Service of the Army, 1917, to the Quartermaster Corps be made accordingly.

George O. Squier,
Lt. Col, Signal Corps.

Approval recommended: H. L. Scott, Major-General, Chief of Staff.
Approved: Newton D. Baker, Secretary of War.

601.1 Hampton, Va. 1st Ind.
O.C.S.O., December 5, 1916.- To the Adjutant General of the Army, recommending approval.

George P. Scriven,
Brigadier General,
C.S.O.

This is a true copy.
Dorothy C. Pyle
DOROTHY C. PYLE
2d Lt., Air Corps
Asst. Historical Officer, F.A.F.

RESTRICTED

DECLASSIFIED
NATIONAL ARCHIVES AND RECORDS ADMINISTRATION 1985
Job No. NND 760015
Date 2/19/1959

Ltr - recommendation for acquisition of land (cont'd)

2501005. 2nd Ind.
W.D., A.G.O., December 8th, 1916 - To the Chief Signal Officer, inviting attention to the approval of the Secretary of War on page 1 hereof.

Wm. M. Cruikshank,
Adjutant General.

A true copy.

/s/ Harry R. Livers,
HARRY R. LIVERS,
Administrative Assistant,
Office of the Post Engineer.

Hampton, Virginia,
November 17th, 1916.

Captain T. T. Milling,
Recording Officer of Board of Officers,
War Department,
Washington, D.C.

Sir:-

We propose to furnish a body of land approximately 2-1/2 miles long by 1-1/4 miles wide, with its longest diagonal distance about 14200 feet or two and seven tenths miles; bounded practically on three sides by water, and containing approximately 1650 acres, as shown by the map thereof hereto attached, marked "A", and to deliver to the possession thereof in two weeks after its acceptance by the United States Governemtn [sic] or as soon as papers can be prepared, etc., provided, however, that such acceptance is made within four months from the date hereof, otherwise this offer to be void, for the price of [$290,000.00] cash, and upon the following terms and conditions:

1. Within ninety working days after the acceptance of title hereto, unless prevented by acts of God, strikes or unusual weather and labor conditions, we will deliver approximately - 1200 - acres of land, clear of all trees, fences, brush, scrubs, poles or other obstructions, as shown by red lines on plat "A" before referred to, except such obstructions as may be occasioned by the natural contour of the land and water, or ditches and ditch banks which now exist on the property; except also the woods in the easterly centre of the tract here offered, known as "Sherwood Woods"; except also such houses as may be now located on the premises included in the lands to be furnished or any of them; except also the trees

This is a true copy.
Dorothy C. Pyle
DOROTHY C. PYLE
2d Lt., Air Corps
Asst. Historical Officer, F.A.F.

in the yard at the site of the present dwelling and farm house on the "Sherwood Farm"; except also the trees at the extreme south-east point of the Sherwood Farm known as "Willoughby's Point"; except also the trees in the yards of the farm house on "Lamington Farm"; except also the pine thicket at the north-easterly end of the Poole Farm; containing about six acres; and except also the strip of woods on the westerly side of the land offered. All of which above exceptions are in accordance with suggestions of the members of the Board who viewed this site. The cleared space to be delivered at the end of said ninety working days from acceptance of title comprises a surface on which Aviation courses may be constructed without hinderance from trees, etc., running practically north and south about 2-1/2 miles and practically east and west about 1-1/4 miles.

2. Within one year after the acceptance of title hereto the woods containing approximately 120 acres before specified as being the easterly center of the tract here offered, and known as "Sherwood" woods, and that portion of the strip of woods on the westerly side of the said property which is shown to be within the red lines on the map "A", containing [1650] acres more or less, and sufficient to straighten the westerly woods line, we will clear away, cutting down the trees and removing such trees, including limbs and all underbrush, the stumps to remain standing.

3. We respectfully submit herewith a communication from the Newport News, Hampton Railway Gas and Electric Company, in which that Company proposes, if the above site is accepted, to construct an equipped electric railroad under the conditions herein set forth, which conditions have been met as to the cost thereof by private subscriptions.

NOTE: The construction of this railroad in contingent at this time upon obtaining the remainder of the necessary right -of -way for same (a greater portion of it having already been obtained) and upon obtaining the necessary privilege from the United States Government to trestle the southwest prong of Back River at the point designated, which is at the head of deep water, the entire body of said south-west prong of said river above the point to be bridged being very shoal with only about two feet depth at low water.

This railroad, when complete, will connect with the tracks of the Newport News Hampton Railway Gas and Electric Company at Hampton, and extend across the southwest prong of Back River to "Sherwood" Farm, a portion of the proposed site on the water and nearest Hampton, a total distance of approximately three miles. It will cross the tracks of the C. & O. R. R. at Hampton and will be constructed with the same guage as the tracks of the said C. & O. R. R. thereby permitting the passage of cars over the said electric line from Hampton to the proposed site for the conveyance of freight or passengers without transferring from their original cars, should it be so desired.

4. We submit herewith a letter from the Newport News Light and Water Company wherein it is proposed to supply water to the proposed site in such quantities as may be necessary from the reservoir of that Company, which reservoir supplies the city water to the Cities of Newport News and Hampton and reservations of the National Soldiers Home and Fortress Monroe, and same to be used for the purposes of the United States at the site herein offered, however, in quantities not less than 50,000 gallons per day.

5. In view of the large expenditures to be made in acquiring title to portions of the tract of land here offered, as well as necessary

expenditures required to clear the same of brush, etc., as herein specified, we will require the purchase price to be paid us in cash, when the deeds are accepted and delivered, in order to meet such expenses. We will, however, execute such sufficient bond or bonds as may be required to insure a faithful compliance with our contract for clearing etc., to be executed hereunder if the site here offered is accepted.

We would respectfully call your attention to the following conditions which we deem very favorable to the location of this Aviation plat at this proposed site:

a. Such additional land as may be necessary for all future purposes may be acquired at a reasonable price. Options for such land could be delivered with this proposal, except for the interests of infants in the adjacent property on the north. These interests would necessitate proceedings through Court before such options could be obtained and the time to submit this proposal is so short as to prevent such procedure at this time.

b. The shores of the property here offered approach the water with a very gentle slope at all points and the rise and fall of the tide in this vicinity is approximately three feet, hence approach from land and water and vice versa are to be had at all times with little or no inconvenience or difference in arrangements.

c. The atmospheric conditions as shown by United States Weather Bureau reports are very favorable to flying in this vicinity, the number of cloudy days, the amount of fog, the amount of high wind and other objectionable weather conditions, being practically at a minimum as compared with most other communities.

d. Notwithstanding the actual course to be delivered clear is only approximately 2-1/2 miles in length, flying machines can proceed for at least one mile beyond each end of the course without encountering any obstructions other than water and hard marsh cleared of trees. This practically makes a course of 4-1/2 or 5 miles in length instead of 2-1/2. there being no woods or trees at either end.

e. There is adjacent and practically bounding the proposed site here offered on two sides a body of water known as Back River, about five miles in length and from two or three miles in width, opening into Chesapeake Bay and available for hydroplane tests and flights. This water is protected from the bay by a sand spit on one side of the mouth thereof and sand bar on the other, with a channel way leading out with from 10 to 15 feet depth of water. This water-way affords not only excellent facilities for hydroplane flights, but also excellent facilities for water transportation to and from the proposed site and nearly all parts thereof, to Old Point Comfort, connecting with the steamship lines of the Old Dominion Steamship Company, the Chesapeake Line of steamships plying between Baltimore and Norfolk, and Norfolk and Washington Steamship Company, plying between Norfolk and Washington and the Old Bay Line, between Norfolk and Baltimore, as well as the N.Y.P. & N. Railroad between Norfolk and New York, and the Chesapeake and Ohio Railway, between Fort Monroe and all points west, including the coal and iron mines of Virginia, West Virginia and Pennsylvania.

f. The proposed site is practically adjacent to Hampton Roads, the largest harbor on the Atlantic coast, and which affords sufficient facilities to anchor all of the ships of the entire Atlantic fleet herein at one time, without congestion, and is the nearest harbor to the Southern Drill Grounds.

g. The proposed site is within one night boat ride over the Norfolk and Washington Steamship lines, and within five hours by train from Washington Steamship lines, and within five hours by train from Washington, the seat of Government.

h. The proposed site is already equipped with wires and supplied with electric current to operate such machinery as may be required at once.

i. A County road constructed of shells leads from the City of Hampton to the property here offered over which transportation can be had by automobile truck or teams to and from the proposed site prior to the time of the erection of the railway line herein provided for.

j. There are seven (7) wells, nearly all of which are equipped with wind mills on the property herein offered which are sufficient to supply a reasonable demand of water until the Newport News Light and Water Company can complete its main to the proposed site as herein provided for, which will enable the Government to proceed at once with the operation and construction of its plant.

k. There is a large body of marsh land at the easterly extremity of York County at the mouth of Back River practically adjacent to the tract of land here offered, extending approximately five miles northwest and south-east, and one mile and a half to two miles north-east and south-west. This, with the exception of a few acres owned by individuals, we are

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informed is the property of the State and used in common by all of the citizens of the easterly part of York County for pasturage for their cattle, we suggest that this can be acquired for the purposes of this Experimental Station, should it be desired.

[H. R. Booker]
[Nelson S. Grooms]
[H. H. Holt]

NATIONAL ARCHIVES AND RECORDS ADMINISTRATION 1985
DECLASSIFIED
Job No. NND 760015
Date 2/19/1959

RESTRICTED

Hampton, Virginia, November 22nd, 1916.

Captain T. T. Milling,
Recording Officer of Board of Officers,
War Department, Washington, D.C.

Sir:

As alte nate proposition No.2 to the one dated November 17th, 1916, and submitted by us to your Honorable Board at Old Point Comfort, Virginia, on November 18th, for an Aviation Experimental Field for the U.S. Government wherein we propose to furnish a tract of land in Elizabeth City County, Virginia, therein described under the terms and conditions and for the price therein setforth, we have the honor to submit the following:

We propose to furnish the body of land described in the said proposition so submitted as being approximately 2½ miles long by 1¼ miles wide, with its longest diagonal about 14200 feet, or 2.7 miles, bounded approximately on three sides by water and containing approximately 1650 acres, as shown on the map thereof filed with our said proposition on November 17th, 1916, and marked "A", and to deliver the possession thereof in two weeks after its acceptance by the United States Government or as soon as papers can be prepared, etc., provided such acceptance is made within four months of the date hereof, otherwise this offer to be void, for the price of $290,000.00 cash, upon the same terms and under the same conditions as set forth in our first mentioned proposition of November 17th, 1916, as to railroad facilities and water; and upon the same terms as to time of payment as therein specified, but with the exception that we propose to deliver the possession of the property in the condition which it now is and which was viewed by your Board on November 18th, without any clearing to be done by us whatever.

In addition we propose, if the site offered by us is accepted as specified, to widen the trestle to be constructed by the railway company in crossing Back River at the time of its construction to twenty feet, so as to accommodate automobiles, trucks, teams and pedestrians, the same to be properly decked with 3 inch creosote lumber, the piles and substructure also to be creosote lumber and the beams and stringers to be of sufficient size to safely accommodate usual traffic passing over the County roads of this County. Also to secure a right of way for an construct a public dirt road the same to be ready for use at the time when the bridge herein provided for is completed, from the southerly terminus of the said bridge to the Main County Road a distance of approximately three-forths (3/4) of a mile, and to execute such proper bond to insure the construction of said bridge and road as may be necessary. It is not proposed herein, However, to maintain either the road or bridge at our expenses, our contract to terminate and our obligations to cease upon the construction and opening of said road and bridge to public traffic.

This is a true copy.
Dorothy C. Pyle
DOROTHY C. PYLE
2d Lt., Air Corps,
Asst. Historical Officer, F.A.F.

RESTRICTED

We also submit herewith a letter from the president of the Newport News and Hampton Railway, Gas and Electric Company, relative to the construction of the proposed railroad and in answer to the question propounded to him by your Board at Old Point Comfort, November 18th, 1916, as to the time of construction of said railroad, should the proposed site be accepted by you.

Very respectfully,

H. R. Booker,
Nelson S. Groome,
H. H. Holt.

Hampton, Virginia

November 17th, 1916.

Messrs. H. R. Booker, N. S. Groome and H. H. Holt,

Hampton, Virginia.

Gentlemen:—

In response to your inquiry as to whether or not there will be objection on my part of having aeroplanes fly over my farm in the County of Elizabeth City or not, or should they be forced to do so to land thereon, provided no damage was done, should the United States Government decide to locate its experimental station in this County, I have the honor to say that I have no objection whatever to aeroplanes flying over any of my property and will raise no objection to having them alight thereon if forced to do so, provided no damage is done to my property.

Very respectfully,

Paul Tabb.

This is a true copy.
Dorothy C. Pyle
DOROTHY C. PYLE
2d Lt., Air Corps
Asst. Historical Officer, F.A.F.

H.R.BOOKER et ux et als
TO
THE UNITED STATES OF AMERICA
Verified:
February 24, 1917
Original to:
Capt. Steger
March 2, 1917

THIS DEED, Made this 30th day of December, in the year of our Lord 1916, by and between Hunter R. Booker and Mattie A. Booker, his wife, Nelson S. Groome and Anne E. Groome, his wife, Harry H. Holt and Mary W. Holt, his wife, all of the County of Elizabeth City and State of Virginia, parties of the first part, and the United States of America, its successors and assigns, parties of the second part.

WITNESSETH: That for and in consideration of the sum of Two Hundred and Ninety Thousand ($290,000.00) Dollars, cash to them in hand paid, the receipt whereof is hereby acknowledged at and before the ensealing and delivery of these presents, they, the said Hunter R. Booker and Mattie A. Booker, his wife, Nelson S. Groome and Anne E. Groome, his wife, and Harry H. Holt and Mary W. Holt, his wife, have granted, bargained, sold and conveyed and by these presents do grant, bargain, sell and convey unto the United States of America and its successors and assigns with covenants of general warranty.

> All of that certain tract, piece or parcel of land, embracing the farms or plantations heretoforeknown as "Sherwood", a part of "Lamington", "Pool's","Bloomfield", a part of "Moorefield", and a part of "Canebrake", situate, lying and being in Wythe Magisterial District, Elizabeth City County, containing as a whole 1650 acres more or less, and bounded and described together as a whole as follows, to-wit: Beginning at a point on the Back River Road at the intersection of the line of the property here conveyed, known as a part of "Moorefield", with the property of Nannie B. Collier and her children, at the center of the lane leading to the old Moore house and running thence North 80° 45' East 780 feet; thence North 89° 10' East 750 feet; thence South 86° 40' East 1246 feet to

A true copy:
Dorothy C. Pyle
DOROTHY C. PYLE
2d Lt., Air Corps
Asst. Historical Officer, F.A.F.

a point in the ditch on the line of Causey's land known as "Bloomfield" Farm; thence South 10° 45' West 453.0 feet; thence South 11° West 822 feet to a point at the corner of "Bloomfield" on the School House lane; thence North 55° East 605 feet along said School House lane; thence North 58° 0' East 151 feet to a point on said School House lane, corner of "Pool's"; thence South 44° 45' East 2766 feet to a point at corner of Jesse S. Jones land; thence North 59° 45' East 873 feet; thence North 47° 5' East 848.5 feet to a ditch at corner of Lamington Farm; thence South 48° 35' East 166.5 feet; thence South 45° 25' East 334.5 feet; thence South 45° 25' East 1313 feet to a point on line of "Sherwood Farm"; thence along line of Sherwood Farm South 3° East 1508 feet to a point at the head of a cove between Sherwood Farm and the Farm of the Hampton Normal and Agricultural Institute known now as Shellbank formerly "Cainbrake"; thence down the center of the said cove following the meanderings thereof to the south-west prong of Back River; thence around the shores of the said south-west prong of Back River following the meanderings of low water mark in a south-easterly and easterly direction to Willoughby's Point; thence continuing to follow the meanderings of low water makr along the shore line of Back River and the north-west prong of Back River and the coves making into the property hereby conveyed therefrom, to the mouth of Tabbs Creek; thence in a westerly direction along the center of said Tabbs Creek following the meanderings thereof to a ditch at the head of same between the property hereby conveyed known as "Moorefield" and the property of Collier, known as "Cloverdale"; thence up the center of the said ditch South 43° 45' West 426 feet, thence along center of said ditch south 44° 0' West 318 feet; thence along center of said ditch South 45° 0' West 1621 feet to the Main Back River Road; thence South 30° 0' East 480 feet along the easterly side of the said Back River Road to the point of beginning at the center of lane to the Old Moore House; all of which said tracts, pieces or parcels of land are embraced in one tract, containing 1650 acres more or less and fully shown, described and designated on the map of the same made by Girard Chambers County Surveyor of Elizabeth City County dated the 30th day of December 1916, hereto attached and hereby made a part of this deed; comprising the same properties which were conveyed to the parties of the first part hereto by deeds of Charles C. Curtis and Fannie C. Curtis, his wife, H. F. Collier and

Rowena S. Collier, his wife, and C. M. Collier and Mary E. Collier, his wife, dated the 11th day of November 1916, by deed of Francis F. Causey, unmarried dated the 11th day of November 1916; by deed of Robert S. Hudgins, Jr., and Grace C. Hudgins, his wife, dated the 11th day of November, 1916; by deed of R. S. Hudgins, a widower, dated November 11th 1916; by deed of Elmer R. Shields and Addie E. Shields, his wife, dated the 11th day of November, 1916; by deed of John B. Kimberly, a widower, dated the 11th day of November, 1916; by deed of F. W. Darling and Mary G. Darling, his wife, dated the 11th day of November 1916, and by deed of the Trustees of the Hampton Normal and Agricultural Institute, dated the 21st day of December 1916.

All of which said deeds convey parts and parcels of the tract herein conveyed to the United States Government and are to be recorded in the Clerk's Office of Elizabeth City County simultaneously with this deed. It is expressly stipulated however that the foregoing property is sold by metes and bounds as shown on said plat of Girard Chambers and not by the above.

The said parties of the first part covenant that they are seized in fee simple of the said land, with all its appurtenances, hereditaments, tenements, rights and privileges; that they have the right to convey the said land to the grantee; that the United States of America shall have quiet possession of the said land, free from all encumbrances, and that they, the said parties of the first part, will execute all such other further and general assurances for the said land as may be requisite, and that they have done no act to encumber the said land.

IN WITNESS WHEREOF, the said Hunter R. Booker, and Mattie A. Booker, his wife, Nelson S. Groome and Anne E. Groome, his wife, and Harry H. Holt and Mary W. Holt, his wife, have hereunto set their hands and seals the day and year first hereinabove written.

This is a true copy.

Hunter R. Booker____________(SEAL)

Mattie A. Booker____________(SEAL)

Nelson S. Groome ____________(SEAL)
Anne E. Groome______________(SEAL)
Harry H. Holt_______________(SEAL)
Mary W. Holt________________(SEAL)

STATE OF VIRGINIA,

COUNTY OF ELIZABETH CITY, to-wit:

I, W. H. Face, a Notary Public, in and for the County aforesaid, in the State of Virginia, whose term of office expires on the 10th day of March 1918, do hereby certify that Hunter R. Booker and Mattie A. Booker, his wife, Nelson S. Groome and Anne E. Groome, his wife, and Harry H. Holt and Mary W. Holt, his wife, whose names are signed to the foregoing writing, bearing date on the 30th day of December, 1916, have this day acknowledged the same before me in my County aforesaid.

Given under my hand this 30th day of December, 1916.

W. H. Face
Notary Public.

F. W. DARLING	"SHERWOOD"	720.0	ACRES
J. B. KIMBERLY	"LAMINGTON"	250.4	"
" " "	"POOLS"	141.6	"
HAMPTON, N.& A. INST.	"CANEBRAKE"	17.0	"
E. R. SHIELD	"BLOOMFIELD"	196.0	"
R. S. HUDGINS Sr.	" "	117.2	"
R. S. HUDGINS Jr.	" "	58.6	"
F. F. CAUSEY	" "	58.6	"
C. C. CURTIS Et als	"MOOREFIELD"	100.0	"
TOTAL		1659.4	"

I, R. E. Wilson, Clerk of the Circuit Court of Elizabeth City County, Virginia, certify that the foregoing is an exact copy of a deed found in Deed Book 60 page 44, excepting therefrom a plat entitled "SITE OF PROPOSED ARMY AVIATION SCHOOL AND EXPERIMENTAL STATION" made by Girard Chambers, County Surveyor December 39th 1916.

Given under my hand this 21st day of November, 1944.

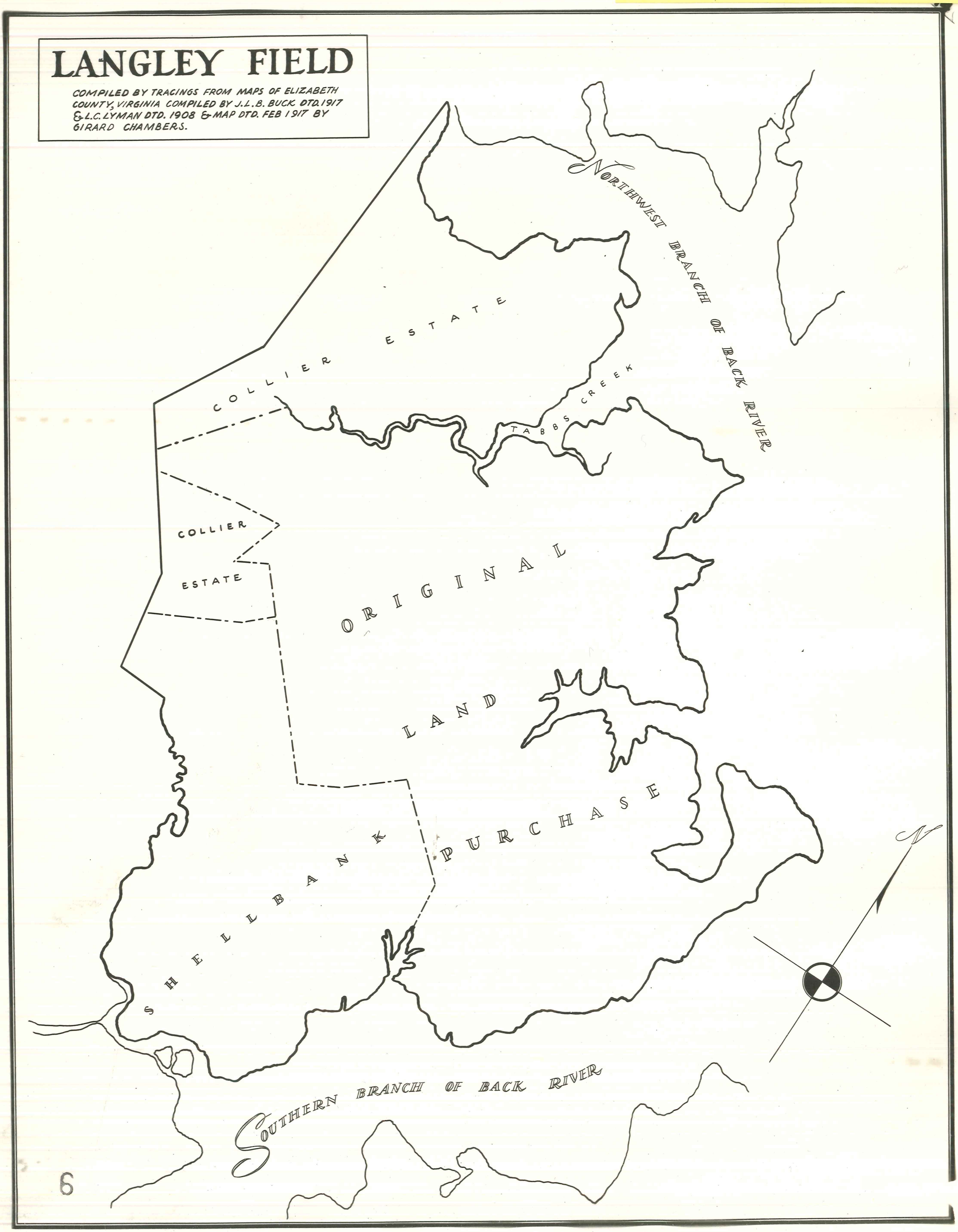
/s/ R. E. Wilson
Clerk.

NATIONAL ARCHIVES AND RECORDS ADMINISTRATION 1985

DECLASSIFIED
Job No. NND 760015
Date 2/19/1959

LANGLEY FIELD

COMPILED BY TRACINGS FROM MAPS OF ELIZABETH COUNTY, VIRGINIA COMPILED BY J.L.B. BUCK DTD. 1917 & L.C. LYMAN DTD. 1908 & MAP DTD. FEB 1917 BY GIRARD CHAMBERS.


NORTHWEST BRANCH OF BACK RIVER
COLLIER ESTATE
TABBS CREEK
COLLIER ESTATE
ORIGINAL LAND PURCHASE
SHELLBANK
SOUTHERN BRANCH OF BACK RIVER
N

Hampton, Virginia, November 8th, 19

Mr. H. R. Booker,
Mr. H. H. Holt,
Mr. Nelson S. Groome.

Gentlemen:-

Referring to the proposed location of the U. S. Army Aviation Experimental Station on Back River and to the requirememt of the Board of Army Officers that a railroad connection must be provided inorder that full car loads of freight consigned to the station can be delivered intact to destination, I beg to advise you that this Company has given most careful consideration to the suggestion that it build and operate a track connection to the proposed location.

The distance from King and Mallory Sts. to the Darling Farm is three miles, of which about 2000 feet is trestle. The cost of the track connection if built at this time and under present high prices of both labor and material will be approximately $90,000,00.

In view of the promise made by Mr. Stevens, President of the Chesapeake & Ohio RR to furnish the rail for this proposed road on a rental basis (the rental to be remitted until such time as the road is self-maintaining) and pay one-half of the cost of the interlocking plane, together with one-half the cost of the maintenance and operation, the total amount of money to be raised will be about $77,000.00-

In considering the question of raising the money necessary to build this railroad we make the following suggestions:

That a railroad corporation be organized to build and operate this track from a connection at King Street with the track of our company to the Darling Farm.

Our Company will subscribe and pay for one-third of the securities that are to be sold to provide the new company with the necessary cash to build the railroad and which is estimated to cose (sic) $90.000.00-

All subscriptions for the purchase of the securities of the new company to be on the same terms and conditions.

Should it be decided to go ahead on the lines above suggested we shall be glad to cooperate promptly and in every way possible.

Yours very truly,

J.N. Shannahan, President,
Newportnews & Hampton Railway Gas and
Electric Company,

A True Copy
/s/ Harry R. Livers,
HARRY R. LIVERS,
Administrative Assistant,
Office of the Post Engineer.

This is a True Copy
Dorothy C. Pyle
Dorothy C. Pyle,

2nd Lt. Air Corps
Asst Historical Officer FAF

DECLASSIFIED
NATIONAL ARCHIVES AND RECORDS ADMINISTRATION 1985
Job No. NND 760015
Date 2/19/1959

RESTRICTED

Dec. 6, 1917

201-W

Mr. John Werth, Supt. of Construction, Langley Field.

Major C. T. Waring, Con. Div., Signal Corps, U. S. A.

Langley Field.

Sir:-

In reply to your verbal order of even date that I submit to you my views and criticisms regarding general conditions in Langley Field, would state that in my opinion the lack of a definite building programme arranged after thoughtful consideration of which portion of the work should be first completed, and a schedule showing when this work will be completed, constitutes one of the most serious causes for criticism that exists in the Field today. Until these two important points are agreed upon jointly by the owner and the Contractor, I do not see how the work can progress in the most economical manner consistent with speed.

Having agreed upon what work is to be done, and having fixed upon a schedule, I would next consider the smallest number of men that would be required to carry on this work in an efficient manner, and see that each man had his proper task assigned him and see that he did it.

In justice to the present Contractors, the fact must not be over looked that when they first took the contract, it was understood that a small force of five hundred or more men would handle the work. About the first of August orders were given to increase this force and rush the construction of such buildings as plans had been gotten out for regardless of whether these were the buildings that were first needed, and an organization was formed to carry on work on the entire Field simultaneously. During the middle of October orders were again changed, causing operations to be directed toward other portions of the work which it is now deemed more important to construct first. The history of the Field up to the first of September is heresay on my part.

The fore going recital of the changes in plan, which caused the Contractor to enlarge his first organization and equipment and then later to direct his forces toward a new building plan, finds him at present without a definite building programme and without a schedule showing when he expects to complete his operations. I criticize the Contractor for not furnishing this information at once.

This is a true copy.
Dorothy C. Pyle
Dorothy C. Pyle
2d Lt., Air Corps
Asst. Historical Officer, F.A.F.

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The Contractor's equipment in regard to housing accommodations, mess and recreation halls for both white and black labor are the best that I have ever seen in a construction camp. Wages paid are equal to those paid on any work of a similar nature in this vicinity. The food served in the Contractor's mess halls is of the best. The machinery equipment is of the best, with the exception of the Keystone shovels, which I do not believe are as efficient as the smaller sizes of the Erie or Thew, this, however, is only a personal opinion of my own.

Now, notwithstanding the magnificent outlay in equipment and quarters and an average supply of labor -- in other words the best of conditions. Why is it we are not getting results?

In the writer's opinion and in plain English, there are too many bosses, and too much division of responsibility. As an illustration, let us consider just one operation (which will serve as a fair example of the others) that of the streets and curbs. On this work which is spread over an area of one hundred by twelve or fifteen hundred feet, there are three general foremen, eight gang foremen, one Field party giving lines and grades and one engineer in the office who I have been told devotes his entire time to streets and curbs. It requires under present management this "over head" to supervise the efforts of seventy-seven - 77 - common laborers, four - 4 - cement finishers, two - 2 - enginemen and fifteen - 15 - teams on this work.

I venture to assert that were this a "unit price" contract instead of "cost plus" that the "over head" would be cut to something approximating the following:- one general foreman, five gang foremen and a portion of one Field party's time, and that the amount of work accomplished would be greater.

Kipling has truthfully said that "The back-bone of the army is the non-commissioned man". Likening the foremen of the Contractor's organization to its "back bone", it appears to me to be rather a spine less affair, for the reason that the greater percentage of these men, seem to be more interested in "putting in time" than in "getting results". There seems to be absolutely no enthusiasm manifested by them toward their work or any effort to push it along.

It appears to the writer that a force of nine general foremen, sixty-eight labor foremen, and seventeen civil engineers (all high priced men) are entirely out of proportion to the size of the job. I believe that the office and clerical force is also greater than it should be.

It appears that the Contractor puts up any structure and every type of structure that he (the Contractor) deems necessary, without consultation with, or the authority of, the proper Government representative, his only explanation of such structures being that they are "only temporary work". This strikes me as an abuse that should be stopped, as in a number of instances the principal advantage of these structures seem to be that they add to the cost of the work.

In several instances important branches of the permanent work have been started and worked on for weeks before general or detail plans have been gotten out or approved by the proper authority. This may be due to the distance separating the Architect and the Contractor, but is a condition which might well be well considered.

As you see, I have confined myself to generalities in this report - - should I enter into details, I would never get this letter into your office in the time allotted to me, and I trust that these criticisms cover what you wanted of me.

I have made no suggestions for as I understand it, you asked for none, but have only attempted to touch on the prominent features of the work in Langley Field that do not strike me as being consistent with good practice.

Respectfully submitted,
John Werth,

JW/CMT

Superintendent of Construction.

A true copy.

/s/ Harry R. Livers
HARRY R. LIVERS,
Administrative Assistant,
Office of the Post Engineer.

This is a true copy.
Dorothy C. Pyle
DOROTHY C. PYLE
2d Lt., Air Corps
Asst. Historical Officer, F.A.F.

RESTRICTED

HEADQUARTERS ARMY AIR BASE
LANGLEY FIELD, VIRGINIA

February 14, 1943

313.6

SUBJECT: Disposition of Illegible Records.

TO : The Adjutant General, Washington, D. C.

1. In view of the necessity for storage space for records at this headquarters, authority is requested to dispose of records contained in fifty-four (54) boxes, 1'X1½'X3' which are now stored in the attic at this headquarters.

2. These records consist of general correspondence such as War Department letters, Circular letters and Publications as pertains to this headquarters and which date from 1914 to 1929 inclusive and were stored in the basement until 1933 when a flood at this base caused high water in the basement, and said records, having been wet, although removed immediately after the flood and stored in the attic, have since become rotten, adherent and illegible, rendering them of no further value.

3. Due to the condition of these records a list cannot be furnished in accordance with paragraph 3, AR 345-10.

For the Commanding Officer:

/s/Alvin B. Tillett
ALVIN B. TILLETT,
Major, Air Corps,
Adjutant.

(SEAL)

AG 313.6 (2-14-43)DZ 1st Ind.
War Department, A. G. O., Washington, D. C., February 17, 1943.

TO: Commanding Officer, Army Air Base, Langley Field, Virginia.

Approved as recommended in paragraph 1.

By order of the Secretary of War:

(SEAL)

/s/[Illegible]Spaulding
Adjutant General.

This is a true copy.
Dorothy C. Pyle
DOROTHY C. PYLE
2d Lt., Air Corps
Asst. Historical Officer, F.A.F.

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REACPITULATION OF COSTS

Langley Field Project Hampton, Virginia

From June, 1917 To March, 1919

COMBINED ACCOUNTS OF CONTRACTOR AND GOVERNMENT

Classification	Contractor	Government	Total
Contractor's Home Office Charges	7,738.65		7,738.65
Indirect & Overhead	427,336.90	88,086.66	515,423.56
Indirect Plant	202,493.76		202,493.76
Preliminary	131,473.10		131,473.10
Clearing & Stumping	111,329.71		111,329.71
Grading	52,928.37	13,705.53	66,633.90
Railway	96,046.25		96,046.25
Power House	52,033.50	148,008.85	200,042.35
Seaplane Hangars	94,694.16		94,694.16
Airplane Hangars	272,392.72	26,001.59	298,394.31
Temporary Airplane Hangars	23,619.25		23,619.25
Boat House & Dock	45,469.87		45,469.87
Gasoline Storage	3,338.43	6,275.19	9,613.62
Engine Storage & Machine Shop	114,203.65	8,893.50	123,097.15
Technical Stores	53,500.86	711.54	54,212.40
Truck Shed	53,761.40	2,721.37	56,482.77
Aircraft Construction Shop	6,655.54		6,655.54
Laboratory Building	257,743.76	60,337.99	318,081.75
Wind Channel Building	6,573.91		6,573.91
Sewerage Disposal Bldg.	1,301.56	3,397.66	4,699.22
Wind Tunnel Building		186.88	186.88
Observation Towers	1,677.99	8.13	1,686.12
Marine Railway Carriage	9,057.34		9,057.34
Bombproof Forts	1,019.96		1,019.96
Gas Tanks	92.27		92.27
Barracks	3,334.82		3,334.82
General Utility Bldg.	49.50		49.50
Seaplane Runway	1,566.89		1,566.89
Alladin Cottages	18,392.50		18,392.50
Administration Bldg.	3,799.28		3,799.28
Civilian Houses	427,946.94	155,377.79	583,324.73
Bomb Towers	2,282,61		2,282.61
Non-Comm. Officers' Quarters	39,134.74	27,283.09	66,417.83
Non-Comm. Officers' Houses	65,772.26	60,548.50	126,320.76
Comm. Officer's Qtrs.	28,748.98	34,015.64	62,764.62

This is a true copy.

RESTRICTED

Dorothy C. Pyle
DOROTHY C. PYLE
2d Lt., Air Corps
Asst. Historical Officer, F.A.F.

#2

Classification	Contractor	Government	Total
Guard House	116.47		116.47
Oil Reclamation & Storage House	2,265.50	8,571.68	10,837.18
Incinerator Building	8,658.31	3,261.89	11,920.20
Roads, Walks, etc.	430,273.09	27,876.03	458,149.12
Dredge & Fill	395,252.60		395,252.60
Street Lighting	2,317.22		2,317.22
Subsoil Drainage	152,832.08	17,819.60	170,651.68
Sanitary Sewer System	130,573.70	22,386.01	152,959.71
Imhoff Tank	13,978.34	5,617.02	19,595.36
Ejector Tank	5,179.74	11,536.72	16,716.46
Storm Water Sewers	73,884.16	10,054.40	83,938.56
Water Distribution Sys.	87,713.34	14,401.97	102,115.31
Steam Distribution Sys.	88.15	49,520.37	49,608.52
Conduit System	191.37	4,716.24	4,907.61
Permanent Telephone Sys.	1,542.00		1,542.00
Camp Investment	304,530.68		304,530.68
Camp Operation	706,331.92	70,433.62	776,765.54
Extra Work & Special Appropriations	379,081.78	92,795.17	471,876.95
Subcontract - Hampton Roads Eng. & Constr. Co	219,491.32		219,491.32
Purchase Plant & Tools	195,907.82	4,639.39	200,547.21
Transferred Stones		4,486.33	4,486.33
Stores On Hand	487,339.26	(161,658.39)	325,680.86
Government Freight	28,665.00		28,665.00
Engineering & Construction Fee	250,000.00		250,000.00
Total Construction Cost	$6,493,725.27	$822,017.96	$7,315,743.23
Less: Interest, Discount & Exchange	7,512.26	377.17	7,889.43
Net Construction Cost	$6,486,213.01	$821,640.79	$7,307,853.80

I certify that this information came from the original records of John Werth, deceased, Superintendent of Construction, Langley Field, 1917 and that the figures here mentioned are true to the best of my knowledge and belief.

/s/ Harry R. Livers
HARRY R. LIVERS
Adm. Asst.
Post Engineer Office
30 November 1944

WAR DEPARTMENT
OFFICE OF THE CONSTRUCTING QUARTERMASTER
Langley Field, Virginia

CQ 615 (Langley Field) January 18, 1935.

SUBJECT: Completion Report.

TO; The Quartermaster, Langley Field, Va.

1. Enclosed is a copy of Completion Report pertaining to Grading and Seeding in Officers' Area and Along Seawall, at Langley Field, Virginia.

/s/ S. S. Winslow,
S. S. WINSLOW,
Major, C.A.C.(w/Q.M.C.),
Constructing Quartermaster.

Incl.
(Compl. Rep.)

This is a true copy.
Dorothy C. Pyle
DOROTHY C. PYLE
2d Lt., Air Corps
Asst. Historical Officer, F.A.F.

OFFICE OF THE CONSTRUCTING QUARTERMASTER
LANGLEY FIELD, VIRGINIA.

January 16, 1935.

COMPLETION REPORT

FOR

GRADING AND SEEDING IN OFFICERS' AREA AND ALONG SEAWALL

AT

LANGLEY FIELD, VIRGINIA.

This is a true copy.
Dorothy C. Pyle
DOROTHY C. PYLE
2d Lt., Air Corps
Asst Historical Officer, F.A.F.

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DECLASSIFIED
NATIONAL ARCHIVES AND RECORDS ADMINISTRATION 1985
Job No. NND 760015
Date 2/19/1959

I. GENERAL.

This completion report covers the grading, seeding and planting in the Officers' Area and along Seawall, and was accomplished by F. J. Gannaway of Norfolk, Virginia, on Contract W-6174-qm-129, dated November 9, 1933.

This project was authorized by letter from the Office of The Quartermaster General dated September 27, 1933, file QM 600.1 C-NB (Langley Field, and was included in the list of suspended projects. The funds for the completion of utilities, grading, seeding, etc. for the Eight Field and Two Double Company Officers' Quarters, which were under way at the time the P.W.A. work started, and also for the additional fill and grading required in connection with the Seawall previously constructed, had been indefinitely suspended. This project had been advertised, but upon notification of the suspension of all construction funds the advertisement was cancelled. The work was again advertised under P.W.A. on October 23, 1933, and bids were opened on November 2nd. Two bids were received and the award was made to F. J. Gannaway in the amount of $17,390.00, for Items I, IV, V, VIII and X of the bid. The contract was awarded on November 8, 1933, but as the sites where the grading, fill and planting were to be done were not yet ready, notice to proceed was not given until February 24, 1934, effective March 5, 1934. The contract provided that work should be commenced March 14th and be completed August 1, 1934. Work actually started on March 14th and was completed May 24, 1934.

II. DESCRIPTION OF COMPLETED PROJECT.

1. General Statement: This project was for finished grading and seeding of all areas shown on plan 11.490 attached, except Area "C", and for adjusting all manholes etc. to the required grade, also all planting shown on plan 11.491. The Contractor also furnished compost harrowed into the soil as specified in Areas "A", "B", "C", "D" and "E".

2. Service: This work was accomplished for the Air Corps, United States Army.

3. Purpose: The purpose of this project was to make more livable the area in which the new Field Officers' Quarters were being built. This area, which included the ground lying south of Dodd Boulevard and extending from the entrance of the reservation to the vicinity of the Post Hospital, was of an irregular

contour, and in rainy weather there was standing water in many places. Officers' Quarters were under construction there but no planting or seeding had been provided.

4. Location: Plans are attached showing the location of this work, all of which was accomplished in the Heavier-Than-Air Section of the United States Government Reservation, Langley Field, Virginia.

5. Equipment: No equipment was installed.

6. Photographs: No Photographs are attached.

7. Plans: Plans and specifications for this work were prepared in the Office of Constructing Quartermaster, Langley Field, Virginia. Plans Nos. 11.490 and 11.491 are attached.

8. Guarantees: The Contractor furnished the guarantee to replace, without cost to the Government, any trees or shrubs planted by him and not living at the end of one year.

III. CONSTRUCTION DATA.

1. General Conditions: As stated in previous paragraph, this work could not be commenced for some months after award was made. The long delay was principally caused by the Contractor who was constructing the Officers' Quarters defaulting, which made necessary the readvertisement of the project. It was not deemed advisable to start the grading, seeding and planting until the buildings were nearly completed.

The only changes made during the life of the contract were covered by Changed Orders "A" and "B". The Quartermaster General's Office furnished a planting plan for Langley Field after this contract had been awarded. It was found that this plan provided for different trees than these already specified. Consequently, on February 27, 1934, Change Order "A" was made increasing the contract in the amount of $280.00, for changing the trees from those specified in the contract to the kind shown in yellow on Plan 11.491, with the exception of the Live-Oak shrub.

Later it became necessary to make some slight changes in the grading of the road in front of the Field Officers' Quarters. This necessitated 327 cubic yards of additional fill which was covered by Change Order "B", issued on April 9, 1934, increasing the contract in the amount of $327.00.

2. Operations by Contractor: This Contractor maintained an adequate organization for the work. The methods used were satisfactory in all respects. The trees and shrubs were furnished the Contractor by a well known nursery in this vicinity and were all under guarantee.

F. J. Gannaway executed this contract in an entirely satisfactory manner, and so far as the records of this office indicate, made all payments to subcontractors, labor and material men promptly. He is recommended for future Government contracts.

3. Progress: Progress chart is attached.

4. Supervision: This project was supervised by the Constructing Quartermaster, Captain E. C. Gere, Q.M.Corps, assisted by Associate Constructing Engineer E. E. McCaffrey. Mr. Caldwell C. Johnson was the Government inspector.

FINANCIAL DATA.

IV. 1. Appropriation:

QM 7490 P 1-3211 A 640-35, N.I.R. War, Q.M.C. 1933-35 (F.P. 136)	$11,523.04
QM 7494 P 1-3214 A 640-35, N.I.R. War, Q.M.C. 1933-35 (F.P. 147)	7,726.00
QM 7092 P 1-3220 A 640-35, N.I.R. War, Q.M.C. 1933-35 (F.P. 151	607.00
	$19,856.04

Amounts expended by purpose numbers for project covered by this report:

P 1-3211	$11,523.04	
P 1-3214	7,726.00	
P 1-3220	607.00	19,856.04
Balance		0

2. Contractor and Contract:

Frank J. Gannaway,
7460 North Shore Road,
Norfolk, Virginia

Contract No. W-6174-qm-129, dated 11/9/33	$17,390.00
Change Order "A",dated 2/27/34 (Increase)	280.00
Change Order "B",dated 4/9/34 (Increase)	327.00
	$17,997.00

NATIONAL ARCHIVES AND RECORDS ADMINISTRATION 1985
DECLASSIFIED
Job No. NND 760015
Date 2/19/1959

3. **Cost:**

Contract cost of Grading, Seeding and Planting	$17,997.00
Overhead	1,859.04
Total	$19,856.04

4. **Final Payment:**

Final payment in the amount of $9,989.46, was made to F. J. Gannaway on voucher prepared by this office May 24, 1934 and paid in the May accounts of the Finance Officer, Langley Field, Virginia.

THIS DEED, made this 1st day of September, A. D. 1917, by and between F. W. Darling, and Mollie G. Darling, his wife, of the City of Hampton, Virginia, parties of the first part, and the United States of America, its successors and assigns, parties of the second part.

WITNESSETH: That Whereas, H. R. Booker, Nelson S. Groome and H_ H_ Holt, acting in accordance with a verbal request of the Board of Army Officers appointed for the purpose of locating a suitable site to establish an Aviation Experimental Station in the United States, did undertake to acquire for the purpose of the Said United States Army Aviation Experimental Station certain waste land and marsh, at the easterly extemity of York County, Virginia, and to that end acquired by purchase in the name of F. W. Darling, from the Egg Island Hunting and fishing Club, (a partnership holding title to its real estate in the name of a Trustee), 220.44 Acres of waste land, so situated at easterly end of York County, and bounded and described as follows, to wit:

All that certain tract or parcel of land, containing 220.44 acres, lying in York County, Virginia, on the waters of Chesapeake Bay, and described by metes and bounds as follows: Beginning at a stob marked "A" on the north waters of Chesapeake Bay thence North 81-1/2 Degrees West a distance of 50.82 chains to a stob marked "B"; thence North 43-1/2 West, a distance of 14.88 chains to a stob marked "C"; thence N. 25-1/4 degrees East, a distance of 60 chains to a stob marked "D"; thence South 25-1/2 degrees East, a distance of 81.16 chains to the point of beginning. And the said parties of the first part, in further compliance with said request of the said Board of Army Officers hereinbefore referred to, also obtained from the

This is a true copy.
Dorothy C. Pyle
DOROTHY C. PYLE
2d Lt, Air Corps,
Asst. Historical Officer, F.A.F.

Register of the land Office of the State of Virginia, at Richmond, Virginia, in the name of said F. W. Darling, Land Office, Treasury Warrant NO. 32165, authorizing the location of not exceeding five thousand acres of land in the State of Virginia and

WHEREAS, in accordance with the laws of Virginia and pursuant to authority in the said Land Office Treasury Warrant NO. 32165 contained, Sydney Smith, Surveyor of York County, Virginia, located 2838.81 acres of land and marsh in the name of F. W. Darling, at the easterly extremity of said York County, Virginia, and returned with his certificate of location a survey and plat of said grant, as required by law, which survey and plat accompanied by the oath and certificate of the Surveyor and Locator, were filed in the office of the Register of the Land Office, at Richmond, Virginia, on the 21st day of February, 1917, in which certificate and survey the land so located pursuant to said Land Office Treasury Warrant, is bounded and described as follows, to wit:-

A certain tract or parcel of land containing two thousand eight hundred and thirty eight and eighty one, one hundredths (2838.81) acres, lying and being in the County of York, in Poquoson District, being the Big Marsh, on Back River, Chesapeake Bay, Floyds Bay, and Sandy Bay, and bounded as follows to wit: Beginning at a stob on the Chesapeake Bay Shore East of the mouth of Muddy Creek, and running thence S. 4-1/4° E. 5412' through the marsh to a stob on Back River Shore; thence S 13-1/2° W. 1808' up Back River Shore to a stob, thence S. 33-3/4° W. 462' 4" up Back River Shore to stob on "Horsecatching Island", thence N. 83-3/4° W 190' 6" up Back River Shore to a Stob on Main Marsh, thence S 47-3/4° W 500' 6" up Back River

Shore to a stob thence N 79-1/2° W 332' 9" up Back River Shore to a stob, thence N. 59° W 362' up Back River Shore to a stob, thence N 35-1/2° E 223' 5" up Back River Shore to a stob, thence N. 29° E 344' 8" up Back River Shore to a stob, thence N 62° W 300' 6" up Back River Shore to a stob Mouth of Bell's Oyster Gut, thence S 65° W 475' 2" across the mouth of Bell's Oyster Gut to stob on Back River Shore, thence N 82-3/4° W 388' 8" up Back River shore to a stob, thence N 80-1/4° W 351' 10" up Back River Shore to a stob, thence S 39-1/2° W 500' 7" up Back River Shore to a stob, 12-3/4° W 230' 9" up Back River Shore to a stob, thence S 81-3/4° West 273' up Back River Shore to a stob, thence N 69-1/2° W 217' 6" to a stob on point, east of Mouth of pages Cove, thence N 17-1/2° W 2442' through east edge of pages Cove to a stob near prong of Pages Cove, thence N 8° W 727' 6" to a stob, in Marsh on Freeman and Firth; thence Firth's line S 88-1/4° E 902' 6" to a stob in marsh at corner; thence Firth's line N 20-1/2° W 926' 8" to a stob on said line; thence N 30-3/4° W 1078' 9" along said line to a stob corner of Firth & Joyner; thence Joyner's line N 29° W 790' to a stob corner Joyner and Topping Estate; thence Toppings line N 39-1/4° W 1031' 6" to a stob in Toppings line; thence Toppings line N 49-1/2° W 1063' to a stob corner of Topping and Page; thence Pages line N 3° W. 655' 7" to a stob off point of woods at East End of Green Pond; thence N 81° W 1267' 2" to a stob back of Green Pond on a line of Pauls estate; thence N 24° W 1920' 9" to a stob at corner of Pauls and Insleys Estates; thence N 42-1/2° W 5332' 8" along the lines of Insleys estate; E. W. Firth, Ensley. Huggett and Lawson estate to a stob on Floyd's Bay west of small creek; thence along Floyd's Bay N 4° W 2023' 7" to a stob on Floyd's Bay Shore, thence N 12° E 990' along Floyd's bay Shore to a stob corner of the 15 acres of R. S. I. H. & W. F. Lawson; thence the said 15 acres line N. 10-3/4° E 1361 feet to a stob in Marsh, corner of said line; thence the said 15 acres line N 47-1/4° W 1153' 6" to a stob at corner of said line, thence the said 15 acres line S 62-1/4° W 144' to a stob at corner of said line on Floyd's Bay Shore; thence N 28-1/4° 1735' 10" along Floyd's Bay Shore across a strip of marsh to a stob on Sandy Bay Shore; thence along Sandy Bay Shore N 31° W 2059' 2" to a stob on Chesapeake Bay Shore, thence along said last Bay Shore N. 41-3/4° E 198' to a stob; thence along said Bay Shore N 22° E 482' to a stob; thence along said Bay Shore N 51-1/2° E 208' 6" to a stob; thence along said Bay Shore N 80-3/4° E 2864' 5" to a stob; thence along said Bay Shore S 88-3/4° E 504' 9" to a stob corner W. E. Lawson Estate; thence Lawson's line across the marsh S 18° E 4748' 5" to a stob on the shore in the bend of Chesapeake Bay; thence along said Bay Shore 74-3/4° E 672' to a stob; thence along said shore S 63-1/2° E 424' to a stob near Forrest Point; thence along said shore S 28° E 1125' 6" to a stob on Nigger Island thence across cove S 38° E 554' 8" to a stob on said Bay Shore: thence along said Bay Shore S 42° E 1177' to a stob on said shore near red Gum Point; thence across Peach Hummock Hollow S 24° E 3727' to a stob on said Bay Shore; thence along said Bay Shore S 56-1/2° E 258' 4" to a stob on said Bay shore; thence along said shore S 70-1/4° E 1221' to a stob on said shore near mouth of Seven Pine Creek; thence across the mouth of said Creek S 35-3/4° E 612' 6" to a stob on said Bay Shore thence along said Bay Shore S 51-3/4° E 405' 8" to a stob; thence along said Bay Shore S 30° E 424' 6" to a stob; thence along said Bay Shore S 41° E 357' 2" to a stob; thence along said Bay Shore S 20° E 155' 6" to a stob; thence along said Bay Shore S 84-1/4° E 906' 3" to a stob; thence along said Bay Shore N 81-1/2° E 616' 8" to a stob mouth of Gum Hummock Creek thence across the mouth of said Creek S 50° E 937' 2" to a stob on said Bay Shore; thence along said Bay Shore S 22-3/4° E 429' 7" to a stob; thence along said Bay Shore S 41° E 264' 1" to a stob; thence along said Bay Shore S 12-3/4° W 145' 5" to a stob; thence along said Bay Shore S 23-3/4° E 242' 9" to a stob; thence along siad Bay Shore S 80-3/4° E 589' 7" to a stob on said shore mouth of Muddy Creek; thence across the mouth of said creek S 45-1/2° E 474' 6" to a stop on said Bay Shore, to a point of beginning, with its appurtenances.

Being the same tract or parcel of land which was conveyed to the said F. W. Darling, by original grant from H. C. Stuart, Governor of Virginia, under the Lesser seal of the Commonwealth, on the 22nd day of August, 1917, pursuant to Land Office Treasury Warrant, No. 32165, and to be recorded simultaneously herewith.

AND WHEREAS, pursuant to the laws of Virginia in such cases made and provided, a grant for the said tract, piece or parcel of land so located by the said Sydney Smith, Surveyor of York County, as aforesaid, in the name of F. W. Darling was issued to the said F. W. Darling by the Honorable H. C. Stuart, Governor of Virginia, under the lesser seal of the Commonwealth on the 22nd day of August, 1917, pursuant to said land Office Treasury Warrant No. 32165; and

WHEREAS, pursuant to the aforesaid verbal instructions of the said Board of Army Officers, it was agreed that the said H. R. Booker, Nelson S. Groome, and H. H. Holt should obtain for the use of said United

States Government Aviation Experimental Station the aforesaid tracts, pieces or parcels of land and convey them to the United States of America at the cost there of, plus certain expenses, etc., and at no profit to the said H. R. Booker, Nelson S. Groome and H. H. Holt, but that they should convey to the United States of America only such title as they might acquire by reason of their aforesaid purchase and grant; they to warrant the title only as against themselves and their heirs and assigns, and F. W. Darling, in whose name said grant and purchase was made, and his heirs and assigns; and there shall be no liability or responsibility on them or either of them to guarantee the title to either of said tracts asagainst any other party or parties whatsoever; and

WHEREAS, pursuant to said verbal instruction, F. W. Darling and Mollie G., his wife, did by their certain deed dated the __day of ___1917, grant and convey unto the United States of America;

All that certain tract or parcel of land, containing 220.44 acres, lying in York County, Virginia, on the waters of Chesapeake Bay and described by metes and bounds as follows: Beginning at a stob marked "A" on the North waters of Chesapeake Bay; thence North 81-1/2° West, a distance of 50.82 chains to a stob marked "B"; thence North 43-1/3° West, a distance of 14.88 chains to a stob marked "C"; thence N. 25-1/4° East, a distance of 60 chains to a stob marked "D"; thence South 25-1/2° East a distance of 81.16 chains to the point of beginning.

It being the same property which was conveyed to the said F. W. Darling by the said Egg Island Hunting and Fishing Club, hereinbefore referred to and the deed therefor_ and an abstgct of the title thereof heretofore delivered to the said Captain J. O. Steger, Quarter-master, United States Army, at Hampton, Virginia, as aforesaid.

NOW THEREFORE, in order to complete their agreement as made by the said H. R. Booker, Nelson S. Groome and H. H. Holt, to and with the said United States of America and convey the remainder of the land so acquired by them, pursuant to said verbal instructions of the said Board of Army Officers hereinbefore setforth, THIS DEED WITNESSETH: that for and in consideration of the sum of Five Thousand Six Hundred and Forty five Dollars and thirty-one cents ($5,645.31) cash in hand paid, the receipt whereof is hereby acknowledged, they, the said F. W. Darling and Mollie G. Darling, his wife, parties of the first part, have granted, bargained, sold and conveyed, and do by these presents grant, bargain sell and convey unto the United States of America, and its successors and assigns, with covenants of Special Warranty, the following described real estate, to-wit:

A certain tract or parcel of land containing two thousand eight hundred and thirty eight, and eighty one, one hundredths (2838.81) acres, lying and being in the County of York, in Poquoson District, being the Big Marsh, on Back River, Chesapeake Bay, Floyds Bay, and Sandy Bay, and Bounded as follows:to-wit:

Beginning at a stob on the Chesapeake Bay Shore East of the mouth of Muddy Creek, and running thence S. 4-1/4° E. 5412' through the marsh to a stob on Back River Shore; thence S 13-1/2° W. 1808' up Back River Shore to a stob, thence S. 33-3/4° W. 462' 4" up Back River Shore to stob, thence S. 71-1/4° W 937' up Back River Shore to a stob on "Horsecatching" Island", thence N 83-3/4° W 190' 6" up Back River Shore to a stob on Main Marsh, thence

S. 47-3/4° W 500' 6" up Back River Shore to a stob thence N 79-1/2° W 332' 9" up Back River Shore to a stob, thence N. 59° W 362' up Back River Shore to a stob, thence N. 35-1/2° E 223' 5" up Back River Shore to a Stob, thence N. 29° E. 344' 5" up Back River Shore to a stob, thence N 62° W 300' 6" up Back River Shore to a stob Mouth of Bell's Oyster Gut, thence S 65° W 475' 2" across the mouth of Bell's Oyster Gut to a stob on Back River Shore, thence N 82-3/4° W 388' 6" up Back River Shore to a stob, thence N 80-1/4° W 351 W' .10" up Black River Shore to a stob, thence S 39-1/2°500' 7" up Back River Shore to a stob, thence S 12-3/4° W 230' 9" up Back River Shore to a stob, thence S 81-3/4° West 273' up Back River Shore to a stob, thence N 69-1/2° W 217' 6" to a stob on point, east of Mouth of Pages Cove, thence N 17-1/2° W 2442' through east edge of Pages Cove to a stob near prong of Pages Cove, thence N 8° W 727' 6" to a stob, in Marsh on Freeman and Firth; thence Firth's line S 88-1/4° E 902' 6" to a stob in marsh at corner; thence Firth's line N 20-1/2° W 926' 8" to a stob on said line; thence N 30-3/4° W 1078' 9" along said line to a stob corner of Firth & Joyner; thence Joyner's line N 29° W 790' to a stob corner Joyner and Topping Estate; thence Toppings line N 39-1/4° W 1031' 6" to a stob in Toppins line; thence Toppins line N 49-1/2° W 1063' to a stob corner of Topping and Page; thence Pages line N 3° W, 655' 7" to a stob off point of woods at East end of Green Pond; thence N. 81° W 1267' 2" to a stob back of Green Pond on a line of Pauls Estate; thence N 24° W 1920' 9" to a stob at Corner of Pauls and Insleys Estates; thence N 42-1/2° W 5332' 8" along the lines of Insleys Estate; E. W. Firth, Ensley, Huggett and Lawson Estate to a stob on Floyd's Bay west of small creek; thence along Floyd's Bay N. 4°

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W 2023' 7" to a stob on Floyd's Bay Shore, thence N 12° E 990' along Floyd's Bay Shore to a stob corner of the 15 acres Line N. 10-3/4° E 1361 feet to a stob in Marsh, corner of said line; thence the said 15 acres line S 62-1/4° W 144' to a stob at corner of said line on Floyd's Bay Shore; thence N 28-1/4° W 1735' 10" along Floyd's Bay Shore across a strip of marsh to a stob on Sandy Bay Shore; thence along Sandy Bay Shore N 31° W 2059' 2" to a stob on Chesapeake Bay Shore, thence along said last Bay Shore N 41-3/4° E 198' to a stob; thence along said Bay Shore N 22° E 482' to a stob; thence along said Bay Shore N. 51-1/2° E. 208' 6" to a stob; thence along said Bay Shore N 80-3/4° E. 2864' 5" to stob; thence along said Bay Shore S 88-3/4° (sic) 3/4° E 504' 9" to a stob corner W. E. Lawson Estate; thence Lawson's line across the marsh S 18° E 4748' 5" to a stob on the shore in the bend of Chesapeake Bay; thence along said Bay Shore S 74-3/4° E 672' to a stob; thence along said Shore S 63-1/2° E 424' to a Stob near Forrest Point; thence along said Shore S 28° E 1125' 6" to a stob on Nigger Island; thence across cove S 38° E 554' 8" to a stob on said Bay Shore; thence along said Bay Shore S 42° E 1177' to a stob on said shore near Red Gum Point; thence across Peach Hummock Hollow S 24° E 3727' to a stob on said Bay Shore; thence along said Bay Shore S 56-1/2° E 258' 4" to a stob on said Bay Shore; thence along said shore S 70-1/4° E 1221' to a stob on said Shore near mouth of seven Pine Creek; thence across the mouth of said Creek S 35-3/4° E. 612' 6" to a stob on said Bay Shore thence along said Bay Shore S 51-3/4° E 405' 8" to a stob; thence along said Bay Shore S 41° E 357' 2" to a stob; thence along said Bay Shore S 20° E 155' 6" to a stob; thence along said Bay Shore S 84-1/4° E. 906' 3" to a stob; thence

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along said Bay Shore N. 81-1/2° E 616' 8" to a stob mouth of Gum Hummock Creek; thence across the mouth of said creek S 50° E. 937' 2" to a stob on said Bay Shore; thence along said Bay Shore S 22-3/4° E 429' 7" to a stob; thence along said Bay Shore S 41° E 264' 1" to a Stob; thence along said Bay Shore S 12-3/4° W 145' 5" to a stob; thence along said Bay Shore S 23-3/4° E. 242' 9" to a stob; thence along said Bay Shore S 80-3/4° E 589' 7" to a stob on said shore mouth of muddy Creek; thence across the mouth of said creek S 45-1/2° E 474' 6" to a stob on said Bay Shore, to a point of beginning, with its appurtenances.

Being the same tract or parcel of land which was conveyed to the said F. W. Darling, by original grant from H. C. Stuart, Governor of Virginia, under the Lesser seal of the Commonwealth, on the 22nd day of August, 1917, pursuant to land Office Treasury Warrant, No. 32165, hereinbefore referred to, as shown by the blue print hereto attached and hereby made a part of this deed.

It being especially stipulated herein that the said parties of the first part only convey hereby such title as they may have acquired in and to the said tract, piece or parcel of land, and that they do not warrant the title thereto against any others than their heirs representatives and assigns.

TO HAVE AND TO HOLD the said tract, piece or parcel of land unto the said United States of America, its successors and assigns forever.

WITNESS the following signatures and seals the day and year first hereinabove written,

F. W. Darling (SEAL)
Nellie C. Darling (SEAL)

State of Virginia,

County of Elizabeth City, to wit:

I, W. H. Face, a notary Public in and for the County aforesaid, in the state of Virginia, whose term of office expires on the 10th day of March, 1922, do hereby certify that F. W. Darling and Mollie G. Darling, his wife, whose names are signed to the foregoing writing, bearing date on the 1st day of September, 1917, have this day acknowledged the same before me in my County aforesaid.

Given under my hand and official seal this 25th day of March, 1920.

Following seal affixed:
W. H. Face, Notary Public
Elizabeth City County, Va.

W. H. Face
Notary Public

Virginia, County of York, to Wit:

In the Clerk's office of the Circuit Court of the County and State aforesaid, the 30th day of November, 1920, the foregoing writing was presented and admitted to record, and, together with the certificate of acknowledgment, recorded in Deed Book NO. 37, pages 353-54-55-56 at 9 o'clock A. M.

Teste:

Floyd Holloway
Clerk-

A copy Teste:

Deed Book No. 37 pages 353-54-55-56.

Extracts, History of Fort Eustis (cont'd)

The 1st Battalion, 21st Engineer (Aviation) Regiment, Langley Field, remained at Fort Eustis until 14 February 1941. The First Chemical Company (Decontamination) remained at Fort Eustis and was transferred to its control until 17 March, when it left for the Edgewood (Maryland) Arsenal.

9 December 1941. Colonel Malcolm Stewart, Operations Officer, Langley Field, called on Fort Eustis to dispatch as many AA weapons as could be spared for the protection of Langley Field, as word had been received that an air attack was expected within two hours. The 6th Coast Artillery Training Battalion furnished one 3 mm AA Gun Battery to occupy a position north of Langley Field and the northwest branch of Back River.

17 January 1944. Langley Field planes dropped 20 hundred pound training bombs, ten of which fell in the vicinity of the Ordnance Ammunition Igloo and ten near the Dozier Farm, adjacent to Post.

22 January 1944. Three, hundred- pound training bombs, released accidentally from Langley Field plane, fell on Fort Eustis, one on Barracks T410, a second near T512 and a third in the Tactical Motor Pool Area.

17 March 1944. Demolition bombs, varying from 100 to 1,000 lbs., were exploded by Langley Field personnel on Mulberry Island, causing minor damages to many post buildings. The commanding officer of Fort Eustis, Colonel Gardner, contacted the commanding officer of Langley Field, Colonel Lohman, requesting this operation be suspended. Colonel Lohman complied.

The Navy had nothing to do with Fort Eustis except the administration of the Naval Hospital located on Mulberry Island.

EXTRACTS, HISTORY OF FORT EUSTIS (MULBERRY ISLAND) VA.
OFFICE OF THE ADJUTANT, FORT EUSTIS, VA.

Ft. Eustis was acquired by the War Department in the spring of 1918 for use as a land and water firing center for the Coast Artillery. The land was purchased by the United States of America from 153 private owners for the sum of $538,000. $10,275,000 was spent on construction, drainage and water systems. The drainage was a storm water sewer system 7.1 miles in length, emptying into the James and the Warwick Rivers. 3.55 miles of concrete roads and 8 miles of slag and gravel roads were laid. Six artesian wells were dug, each one 400 feet deep. The elevation of Mulberry Island is 8.5 feet; the total overage, 7,983 acres, of which the Camp area comprises 2,311 acres.

From 1918 until the spring of 1934, Fort Eustis was controlled by the Coast Artillery, and garrisoned by the 51st and 52nd Coast Artillery and the 34th Infantry.

In October 1934 Fort Eustis was taken over by the Department of Justice and converted into a camp for 5,500 Bonus Marchers and Transients. In August 1936, the Virginia WPA and NYA took over Fort Eustis and installed between 200 and 300 men. During this month practically the whole installation was demolished by burning, salvaging, or selling. The laundry, chapel, theater, canteen and some barracks were destroyed by fire.

From September 1936 to January 1941 Fort Eustis remained a shell, used mainly as a maneuver area and bombing range under the direct supervision of Langley Field, until again taken over as a Replacement Training Center by the Coast Artillery, 24 January 1941, at which time Fort Eustis was discontinued as a sub-base of Langley Field.

This is a true copy.
Dorothy C. Pyle
DOROTHY C. PYLE
2d Lt., Air Corps
Base Historical Officer, F.A.F.

COMMANDING OFFICERS OF LANGLEY FIELD

1917 - 9 March 1935

Major John C. P. Bartholf	July	September 14, 1917
Lt. Col. William Jay Patterson	October 1917	June 1918
Major C. W. Howard	August 1918	January 1919
Major Frank. D. Lackland	January 1919	May 1919
Col. W. N. Hensley	May 1919	July 1919
Col. T. F. Dodd	July 1919	October 1919
Major J. N. Reynolds	October 1919	April 17, 1920
Col. W. N. Hensley	April 19, 1919	July 15, 1921
Brig. Gen. Charles H. Danforth	July 1921	June 1924
Lt. Col. Harry Graham	June 1924	September 1924
Major Oscar Westover	September 1924	September 1926
Col. C. C. Culver	September 1926	June 1929
Col. Jacob W. S. Wuest	June 29, 1929	June 15, 1930
Col. Roy C. Kirtland	July 14, 1930	July 12, 1932
Col. C. C. Culver	July 1930	October 1933
Lt. Col. A. L. Sneed	October 1933	June 1934
Brig. Gen. Charles H. Danforth	June 1934	March 8, 1935

REPO[illegible] SHEET—REPORT OF SICK AN[illegible]OUNDED AT

POST HOSPITAL, LANGLEY FIELD, HAMPTON, VA.
(Here state the name of the hospital, infirmary or Medical Department organization, and give its location on the last day covered by the report.)

MONTH OF OCTOBER 1917
(Give beginning and end of period, if less than a month.)

COMMAND:

(Here specify the command and the companies and detachments composing it on the last day covered by the report, together with the brigade, tactical division and field army, or territorial department, of which it forms a part.)

119th Aero Squadron, A.S.S.C., Detachment Quartermaster Corps, Detachment Medical Department, Detachment Photo Division, A.S.S.C., and Detachment Ordnance Department.

THIS FOLD OUTSIDE.

(State important variations from the general composition of the command, as the arrival or departure of companies, giving the dates thereof respectively, and the names of accompanying medical officers. Reports relating to commands in the field should show the location of the principal camps occupied during the month, with the dates of arrival at and departure from each. When a hospital is opened or closed, or a Medical Department organization discontinued, during the period of the report, the fact and date thereof should be recorded and the orders directing it be cited.)

Post Hospital opened per G.O. 104, Par. 1, dated August 7th, 1917, making this station a post.

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Mean strength of command, for 31 days.

Officers			34	
Enlisted men	American troops	White	183	Total 217
		Colored		
	Filipino			
	Porto Rican			
Indian Scouts				

NUMERICAL REPORT FOR THE MONTH

	Remaining from last month.	ADMISSIONS.			Total to be accounted for.	COMPLETED CASES.								REMAINING.		AGGREGATE NO. OF DAYS LOST FROM SICKNESS.	
		From command.	From Other sources.			Returned to duty.	Died.	Discharged for disability.	Deserted.	Discharged by expiration of term.	Transferred to insane asylum.	Transferred to other hospital.	Otherwise disposed of.	Hos.	Qrs.	In hospital.	In quarters.
			By transfer.	Otherwise.													
Officers and soldiers on the active lists of the Army [1]	0	14	0	0	14	5	-	-	-	-	-	6	1	-	2	-	52
Retired officers and soldiers under assignment to active duty [1]																	
All others [2]																	Not used.

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[1] Cases, including deaths, which are carded for record only, among those who are not currently on the register of patients, will be tabulated above the line in the proper space under *completed cases.*

[2] "All others," which comprises those on the status of civilians (see Instruction 3 on reverse) will be reported in this summary *only* when they receive hospital treatment or die.

I CERTIFY that this sheet and the accompanying list and cards are a true and correct exhibit of the sick and wounded of the command specified above for the period indicated. Cards of 12 completed cases accompany this sheet.

1st Lieut., M.R.C., *U. S. Army, Surgeon.*

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Form 51
MEDICAL DEPARTMENT, U. S. ARMY
(Revised Feb. 18, 1916)

INSTRUCTIONS

1. The Report of Sick and Wounded comprises the report sheet, Form 51, the nominal check list, Forms 51a and 51b, and the report cards, Form 52.

2. The mean strength of the command for the period covered by the report will be computed as follows: The totals of strength for each day of the period noted by the adjutant upon the surgeon's morning reports of sick will be added together by heads or items (officers, white enlisted men, colored enlisted men, etc., separately) and divided by the number of days constituting the period. The quotients are the mean strength by items, and their sum is the total mean strength.

(a) The foregoing is the rule for commands which are intact. When, however, a part of the command is on field or detached service accompanied by a medical officer, who will himself conformably to regulations render a report of sick and wounded, appropriate deduction should be made in computing the strength at the main or permanent station. Conversely, when the sick and injured among troops, not accompanied by a medical officer, which are in the vicinity of the command, but are not properly a part of it, are habitually admitted to its hospital or infirmary, or taken up on its register, appropriate addition to the strength of command should be made.

(b) The mean strength of Medical Department organizations, such as general hospitals, base hospitals, evacuation hospitals, field hospitals, hospital trains and hospital ships, will include the personnel of such organizations only; it will not include the sick and wounded therewith who were admitted by transfer (except sick and wounded personnel readmitted by transfer), or the strength of the commands from which such transferred cases came or to which they belong.

3. The number of civilians with the command will be indicated in the diagram on the third fold of this sheet, together with the number of cases of disease and injury among them. Officers and enlisted men on the retired lists who are not under assignment to active duty, ex-officers, ex-soldiers, applicants for enlistment who have not been sworn in, and members of the organized militia not mustered into the service of the United States, all have the status of civilians for the purpose of this tabulation while with army commands.

4. The record of birth will give the date of birth, the sex and name of the child, the name, rank, etc., of the father, or if a civilian his occupation, the maiden name of the mother, and whether the child is the first or second, etc., of the marriage. The record of marriage will give the date of the marriage, the name, age, birthplace, and rank, etc., or occupation of the groom, and the name, age, and birthplace of the bride. The record of death will show the date of the death, the name, sex, and age of the deceased, and the cause of death.

5. The report card will be a full and exact transcript of its register card as the latter stands on the last day covered by the report, except in spaces 19, 20, and 26. Space 19 will be filled out in every case. Space 20 will be filled out on report cards from mobile or field commands as follows: After the word "from" will be noted the location of the hospital or organization on the last day covered by the report, if it is different from the location given in space 18; if, however, the location on the last day is the same as that given in space 18, then the word "same" will be entered in space 20. Space 20 need not be filled out on the report cards from a hospital which is permanently located in one place. Space 26 on the report card of a case brought forward from the preceding year will include the days of treatment in that case during the current year only. The upper and lower margins on the front of the card, and the upper margin on the back, should be left blank.

6. Entries on the report sheet, nominal lists, and report cards should be made with the typewriter, when possible. They should be plainly and carefully written, using permanent black ink.

7. For mailing: With back of sheet up, fold forward from bottom to top, and again forward in like manner, thus producing four folds with the designation of the hospital, etc., and month on the outside.

3—3645

CIVILIAN POPULATION WITH THE COMMAND

(See Instruction 3.)

NUMBER OF—	MEN.	WOMEN.	CHILDREN.	TOTAL.
Persons (averaged for the month)	2900	70	30	3000
Cases of disease	34	-	-	34
Cases of injury	-	-	-	-
Total Cases	34	-	-	34

BIRTHS, MARRIAGES, AND DEATHS

(See Instruction 4.)

One death, October 4th, 1917, Andrew Smith, Colored employee of construction Company on post, male, age 20, accidently killed by touching electric trolley wire while standing on top of a steel box car.

SEAL

HEADQUARTERS LANGLEY FIELD
LANGLEY FIELD, VIRGINIA.

July 3, 1932.

MEMORANDUM FOR: All Unit Commanders.

The following figures indicate the authorized enlisted strength of the Air Corps organizations of this command:

1st Bombardment Brigade Hq.	15
28th Communications Section	17
2nd Bombardment Wing Headquarters	14
2nd " " Band	28
8th Pursuit Group Hq.	35
33rd Pursuit Squadron	132
35th Pursuit Squadron	132
36th Pursuit Squadron	132
58th Service Squadron	172
2nd Bombardment Group Hq.	35
20th Bombardment Squadron	132
49th Bombardment Squadron	132
96th Bombardment Squadron	132
59th Service Squadron	172
2nd Photo Section	20
19th Airship Co.	170
Flight "A", 16th Observation	25
TOTAL	1495

By order of Colonel KIRTLAND:

G. L. USHER,
Captain, Air Corps,
Adjutant.

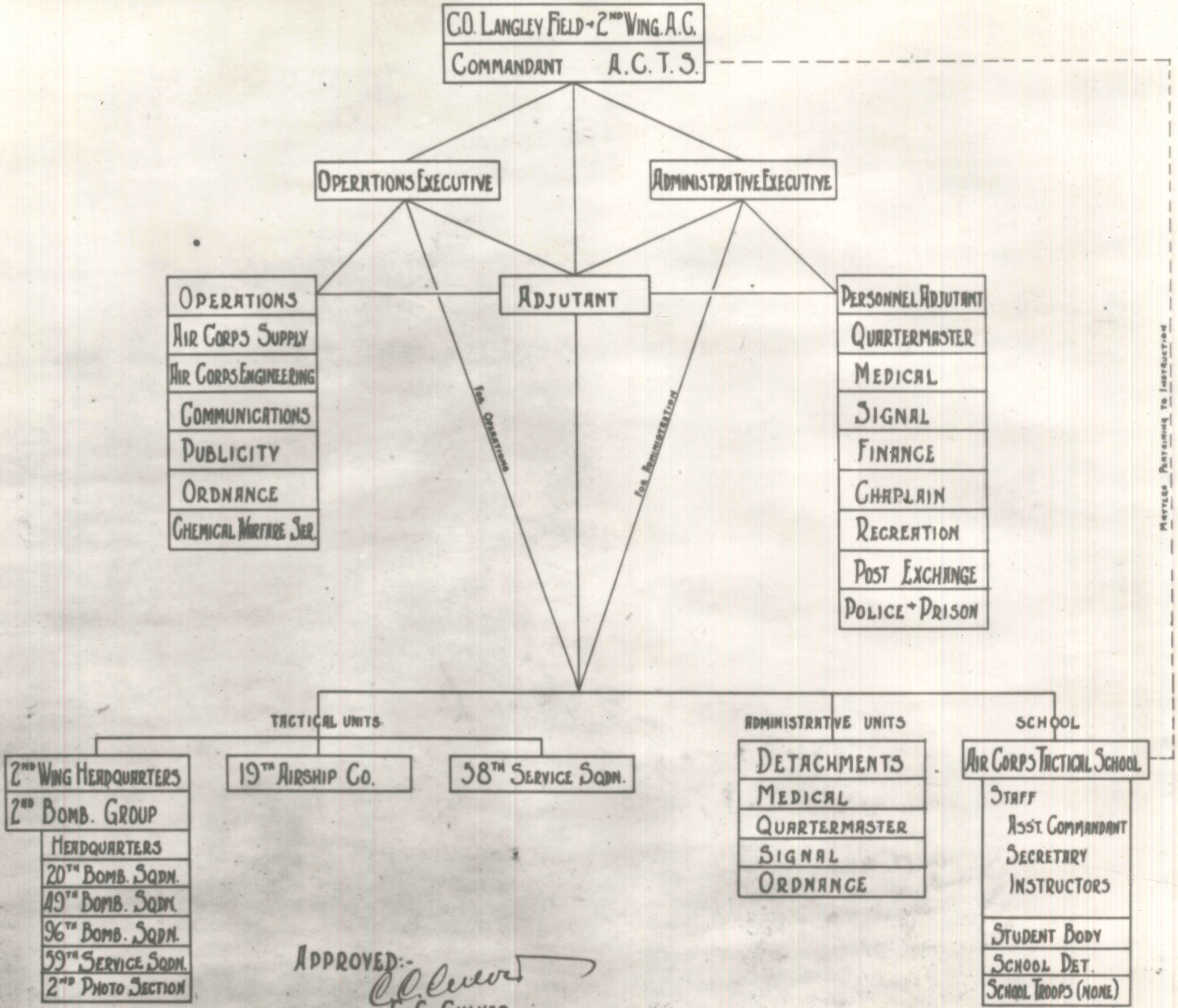
Copies -
1 to each of above units.
File.

This is a true copy.
Dorothy C. Pyle
DOROTHY C. PYLE,
2nd Lt., Air Corps,
Asst. Historical Officer, FAF

ORGANIZATION

LANGLEY FIELD AND 2ND WING AIR CORPS

JULY 23, 1928


C.O. LANGLEY FIELD + 2ND WING A.C.
COMMANDANT A.C.T.S.
OPERATIONS EXECUTIVE
ADMINISTRATIVE EXECUTIVE
ADJUTANT
OPERATIONS
AIR CORPS SUPPLY
AIR CORPS ENGINEERING
COMMUNICATIONS
PUBLICITY
ORDNANCE
CHEMICAL WARFARE SER.
PERSONNEL ADJUTANT
QUARTERMASTER
MEDICAL
SIGNAL
FINANCE
CHAPLAIN
RECREATION
POST EXCHANGE
POLICE + PRISON
FOR OPERATIONS
FOR ADMINISTRATION
MATTERS PERTAINING TO INSTRUCTION
TACTICAL UNITS
2ND WING HEADQUARTERS
2ND BOMB. GROUP
HEADQUARTERS
20TH BOMB. SQDN.
49TH BOMB. SQDN.
96TH BOMB. SQDN.
59TH SERVICE SQDN.
2ND PHOTO SECTION
19TH AIRSHIP CO.
58TH SERVICE SQDN.
ADMINISTRATIVE UNITS
DETACHMENTS
MEDICAL
QUARTERMASTER
SIGNAL
ORDNANCE
SCHOOL
AIR CORPS TACTICAL SCHOOL
STAFF
ASST. COMMANDANT
SECRETARY
INSTRUCTORS
STUDENT BODY
SCHOOL DET.
SCHOOL TROOPS (NONE)

APPROVED:-
C.C. Culver
C. C. CULVER
LIEUT. COL., AIR CORPS,
COMMANDING.

REC'D FEB 8 1

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Date 2/19/1959

AERONAUTICAL RESEARCH AND THE N.A.C.A.

By

S. Paul Johnston
Coordinator of Research
National Advisory Committee for Aeronautics

Article submitted to "Aeronautics" 1940

Research is simply the process of finding out things that we want to know. It may be as simple as dropping a pebble into a pond, or it may be as complicated as the measurement of the velocities of electrons. In the first case a stone is all the apparatus we need. The second requires one of those amazingly complicated gadgets known as a cyclotron, and a whole laboratory full of equipment.

Between these two extremes is an infinite range of research that touches every industrial process, and every phase of life. Not one of the things with which we come in contact every day, our food, our clothing, the cars in which we ride, the houses in which we live, but is a direct result of thousands of man-hours of research. Research makes possible cheaper and better goods that make for higher standards of living. Research is responsible for our great systems of transportation and communication. Research makes more efficient weapons for national defense.

Few industries owe more to research than aviation. The story of the development of the airplane is one of continuous research and refinement. The first tools for aeronautic research were crude and limited in their capabilities. With time they have been improved and made infinitely more efficient. Today science has put at the disposal of the aeronautical engineer tools of a precision and on a scale matched in few other industries.

The first and only research equipment available to the early experimenters was simply the flying model. The Montgolfiers

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first tested their theories of aerostation with a small-scale hot-air balloon. Monck Mason in 1843, and Pierre Julienne two years later, first demonstrated the practicability of the airship by model flying. Sir George Cayley's work in 1804 with model gliders was the basis on which much of our present theory of heavier-than-air flight depends, and Stringfellow's 16-foot monoplane model of 1848 was the first heavier-than-air machine to achieve controlled horizontal flight under its own power.

Models still are the basis for the most important phase of aeronautical research, but the technique has changed radically. It is easy to demonstrate that a machine will sustain itself in the air by simply flying a model, but it is extremely difficult from such methods to find out why it flies and the detailed behavior of the air flow over the various parts. Obviously, actual measurements are impossible. The whole performance is of the "hit-or-miss" trial and error variety.

Some of the experimenters of the late 19th century tried to overcome this difficulty by testing their models in circular paths, tethered to a stake. In this way they kept the machine under control and were able to make some observations as to what was going on. A modification of tethered experimental flight is the whirling arm, first used in this country by Professor Samuel P. Langley in the 1880's. His apparatus consisted of a counter-balanced beam 30 feet long, pivoted near one end and rotated in a horizontal plane by means of a steam engine. At the end of the arm traveling around the 60-foot circle he was able to develop speeds up to 70 miles an hour. By mounting plates and airfoils of various size and shape on the free end of the arm, he was able to develop some theories of air resistance of bodies, and lift and drag of wings. At one point he even mounted stuffed birds on the end of the arm to try to discover something of their aerodynamic characteristics.

Although the whirling arm is better as a research tool than free model flight, it has its limitations. Today it is used only for special types of aerodynamic investigation. There is only one such installation in this country, that of the Guggenheim Airship Institute at the University of Akron. For most purposes, free model flight and whirling arm tests have been replaced by wind tunnel research.

The wind tunnel is far and away the most important device for aeronautical research. Hold a stiff piece of cardboard in the blast from an electric fan, and you have the essentials of a wind tunnel. Instead of creating air flow over wings and tail surfaces by projecting a model through still air, the model is held stationary on suitable balances or other measuring devices and a stream of air is made to flow around it. The machine actually "flies" while standing still, making it quite possible to take accurate observations and tests of its behavior. There are some characteristics, of course, that cannot be determined in this fashion, but in properly built wind tunnels fitted with accurate balances, it is possible to obtain a very good idea of how the full-sized airplane will behave in the air.

It is clearly much cheaper to be able to test small-scale models than it is to design and build full-scale machines. It

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is also much safer. A great many of the hazards of test-flying new and untried airplanes that were faced by the Wrights, Curtiss, Bleriot and others of the 1903 to 1914 period have been eliminated by wind tunnel tests.

The Wrights did a great deal of their early investigations in a crude wind tunnel at Dayton. During the summers of 1900-1902 they experimented with full-scale kites and gliders on the sand dunes at Kitty Hawk. During the winters of those years they checked their flight work and acquired a detailed knowledge of wing behavior by means of their wind tunnel. Their equipment was not large enough to check complete models but what they learned from that research gave them confidence in the ability of their full-size machine to fly.

During the 10 years preceding the outbreak of the war in 1914 many wind tunnels were built in many countries. The pressure to produce faster and more efficient fighters during the first World War gave great impetus to all forms of aeronautical research. It was during that period that the great laboratories of England, of France, and of Germany were established.

A modern wind tunnel is a good deal more complicated machine than a simple combination of fan and model. In order to get any worthwhile results it is necessary to produce an air stream that flows smoothly in straight lines as it passes the model. Of importance then, is a system of passageways and screens that will take out the twist that a fan or propeller ordinarily imparts to an air stream. This can be done by the introduction of vanes or 19 grids usually called "honeycombs" because of a marked similarity to that natural structure.

The earliest wind tunnels were of the "straight-through" type, air being drawn in at one end, straightened out over honeycombs, passed over the model, and discharged again into the atmosphere. In general appearance, such wind tunnels are similar to a huge venturi tube such as those mounted on many airplanes to drive vacuum instruments.

As the demands for accuracy and for size and speed of wind tunnels increased, such a simple form proved inadequate. Most large wind tunnels today re-circulate air through return passages so that the same air goes round and round through the wind tunnel continuously. This system is much more complicated and far more expensive, but it permits much more accurate control of the conditions of test than does the straight-through type.

Since it is desirable to make tests on models at somewhere near the speed of actual flight, wind tunnel speeds have been stepped-up tremendously over the past 10 years. Before 1930 there were few wind tunnels in the world with air speeds much over 100 to 120 miles an hour. Today the huge tunnels at Langley Field and at Moffett Field can handle air in the 300 to 400 mile an hour range, and plans are under way to extend that even further. In fact, some tunnels are already in existence which work in the so-called supersonic range, that is, at speeds greater than the speed of sound in air.

Model size is also an important factor in wind tunnel work Although it is possible to make reasonably accurate predictions of full-scale airplane behavior based on tests of a model having a span of, say, 12 to 18 inches, there are many uncertainties involved and many intricate calculations necessary to apply the proper correction factors. Research men speak frequently of "Reynolds Number". Reynolds was a British physicist who worked out the general relationships of such elements as model size, air speed, and air density, from which full-scale performance may be predicted from model tests. The so-called Reynolds Number of any particular test is an indication of the scale on which it is run. For example, if you test a 3 inch by 6 inch wing model in an air stream of approximately 30 miles an hour, the corresponding Reynolds Number would be about 70,000. If you stepped the model size up, to 18 inches by 60 inches, and the air stream to 100 miles an hour, the Reynolds number would be about 1,350,000. A full-scale airplane of the light class, say, with a span of 40 feet and a top speed of 90 miles an hour, would have a Reynolds Number of about 4,000,000 while a modern bomber or transport of 100 foot span and 200 miles an hour top speed would be somewhere in the range approaching 20,000,000.

In order to minimize the effect of uncertainties of applying correction factors, it is desirable to make wind tunnel tests at as high a Reynolds Number as possible. That is the reason why the latest tunnels built are of such huge size and operate at such high speeds. That is why Langley Field has a full-scale wind tunnel that will take a complete airplane up to about a 45-foot span for test in an air stream well over 100 miles an hour. That is why the latest equipment can test a model up to 10 foot span at speeds well above 300 miles an hour. Such installations are major engineering projects. Such tunnels require from one to two years to build and may cost between one and two million dollars.

The wind tunnel has a number of interesting variations for special purposes. For example, in order to test the behavior of models in tail spins, vertical wind tunnels have been built in which the air blast is directed upward and can be so controlled that the upward velocity is exactly equal to the sinking speed of the spinning models. The models simply spin about at a constant level in the air stream. Thus, research engineers can conveniently observe their behavior and can readily test out methods of effecting recovery. Another special form is the free-light tunnel, in which the air stream is inclined to correspond exactly to the gliding angle of a flying model. In such a tunnel, by means of a system of delicate and intricate controls, it is possible to observe the behavior of a model in free flight and to control it exactly as one would control a full-size airplane in the air.

Important as it is, the wind tunnel with its variations is only one of a number of tools for aeronautical research. The behavior of seaplanes and flying boats when taking off and landing is of tremendous importance, both to the Navy and to commercial operators. In order to test the characteristics of hulls of various shapes, towing basins are very useful. By means of a traveling carriage straddling a long tank of water, models may be towed at varying speeds and their behavior measured by suitable equipment. This is the same idea that has been used for many years by naval architects to test ship hulls. The main difference, however, is that the towing speeds for aircraft float have been stepped up considerably to approach as closely as possible those at full scale.

Engine problems are many and varied and require extensive laboratories to test behavior at low and at high altitudes. Also, the processes of making the tests and measurements of airplanes and engines require a vast and complicated instrumentation. All the resources of physics and chemistry have been called upon to provide convenient and accurate methods of measuring and recording phenomena of all kinds, on the ground and in the air.

Not the least part of the work of an aeronautical research laboratory is that of its flight section. In the end, it is the actual behavior of the airplane itself that matters, and not the performance of a model in a wind tunnel. Research pilots do their work without the glamor that surrounds the manufacturer's test pilot whose job it is to make spectacular dives and pullouts in order to make finally certain that the completed airplane will not come apart in the air. They drape their machines over with a collection of strange gadgets, from which records are made of the detailed performance of every element of the machine. It is from the work of a corps of engineering pilots who, day in and day out, fly thousands of miles to check and recheck the work of the wind tunnel researchers that much of the amazing progress in aeronautics has come.

The extraordinarily rapid rise of German air power in the last few years has stemmed directly from an intensive aeronautical research program which was set up years ago as an integral part of her rearmament plan. Not only has she produced large quantities of aircraft of excellent performance and good structural characteristics, but she has provided them with such essential details as self-sealing fuel tanks and light-weight armor for personnel. Constant attention to research has been one of the most important elements in the creation of what has proven to be the most formidable air force in the world.

Italy has also been active in developing her aeronautical research facilities. She has built a whole city near Rome dedicated to aeronautical research. It has been named Guidonia, in honor of one of her outstanding military aviators. It is excellently equipped and efficiently staffed and is turning out first-rate results.

France and England have been pioneering for many years in aeronautical research. The French developed, among other things, a full-scale wind tunnel at Chalais-Meudon, and built an excellently equipped construction and flight research station at Villacoublay.

Great Britain depends largly on the National Physical Laboratory for fundamental research in aeronautics, supplemented by the more practical work of the Royal Aircraft Establishment at Farnborough. Flight test work for the Royal Air Force and for the Royal Air Arm of the Fleet goes on at Martlesham Heath and at Felixstowe.

Just prior to the entry of the United States into the last war it became increasingly plain that some sort of organized aeronautical research was necessary if we were to keep up with the rapid developments abroad. It was then that the National Advisory Committee for Aeronautics was established by Act of Congress approved March 3, 1915, reading as follows:

> "An Advisory Committee for Aeronautics is hereby established, and the President is authorized to appoint not to exceed twelve members, to consist of two members from the War Department, from the office in charge of military aeronautics; two members from the Navy Department, from the office in charge of naval aeronautics; a representative each of the Smithsonian Institution,

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> of the United States Weather Bureau, and of the United States Bureau of Standards; together with not more than five additional persons who shall be acquainted with the needs of aeronautical science, either civil or military, or skilled in aeronautical engineering or its allied sciences: PROVIDED, That the members of the Advisory Committee for Aeronautics, as such, shall serve without compensation: PROVIDED FURTHER, That it shall be the duty of the Advisory Committee for Aeronautics to supervise and direct the scientific study of the problems of flight, with a view to their practical solution, and to determine the problems which should be experimentally attacked, and to discuss their solution and their application to practical questions. In the event of a laboratory or laboratories, either in whole or in part, being placed under the direction of the committee, the committee may direct and conduct research and experiment in aeronautics in such laboratory or laboratories.

In order to carry out this important task, the munificent sum of $5,000 a year was appropriated. Some understanding of the growth of the N.A.C.A. may be obtained by contrasting this amount with the appropriations for the fiscal 1940, which totaled $2,289,020.

Appointments to the Committee were made from the outstanding military and civilian experts of the time. They included for the Army, Brigadier General George P. Scriven, Chief Signal Officer, and Lieutenant Colonel Samuel Reber. Representing the Navy were Captain Mark L. Bristol, Director of Naval Aeronautics, and Naval Constructor H. C. Richardson. The other Government services represented were the United States Weather Bureau, by Professor Charles F. Marvin, the Bureau of Standards by Dr. S. W. Stratton, the Smithsonian Institution by Dr. Charles D. Walcott, and the Treasury Department by the Honorable Byron R. Newton. The Civilian list included Dr. Joseph S. Ames, of Johns Hopkins University, Professor John F. Hayford, of Northwestern University, Professor Michael I. Pupin, of Columbia University, and Professor William F. Durand of Leland Stanford University.

On March 2, 1929, the membership of the Committee was increased from the original twelve to fifteen, the figure at which it stands today. Members are appointed by the President, to include two representatives each of the War and Navy Departments, two representatives of the C.A.A., one representative of the Smithsonian Institution, the U.S. Weather Bureau, and the National Bureau of Standards, and six additional persons who are "acquainted with the needs of aeronautical science, either civil or military, or skilled in aeronautical engineering or its allied sciences." The latter group serve for terms of five years.

The present Chairman of the NACA is Dr. Vannevar Bush, formerly of Massachusetts Institute of Technology, and now President of the Carnegie Institution of Washington. Dr. Bush is also Chairman of the newly formed National Defense Research Committee. Between the N.A.C.A. and the N.D.R.C. he shoulders direct responsibility for the coordination and progress of all research in the United States that has any bearing on our defense problems in the air, on land, and at sea.

Because of the close relationships that exist between the work of the Committee and the work of the Army and Navy, its Washington headquarters are in the Navy Building. Here are located the executive offices of the Committee, together with its main files, and the office of Aeronautical Intelligence, which was established in 1918 as an integral part of the Committee's activities. It not only maintains the technical and historical files but operates an extensive research library and serves as the distributing agency for the reports on the Committee's work.

The Office of Aeronautical Intelligence distributes publications in three forms, first, Technical Reports, on major researches conducted in Committee laboratories, second, Technical Notes, covering preliminary reports on N.A.C.A. researches, reports on aeronautical research in

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schools and universities, and reports on other matters that would be of interest to aeronautical engineers. The Technical Memorandums of the O.A.I. include reprints of translations of technical articles in aeronautics gathered from many sources throughout the world.

Until just before the fall of Paris during the present war, the Committee maintained an office in the French capital, its function was to keep informed on the progress of aeronautics abroad. Mr. John Jay Ide has been Technical Assistant in Europe for many years, and by visiting governmental and private agencies has kept the Committee up to date on aeronautical affairs all over the world. Just before the German invasion, however, the Paris Office was officially closed and Mr. Ide returned to the United States.

The responsibility for all aeronautical research under the N.A.C.A. is in the hands of Dr. George W. Lewis, Director of Aeronautical Research. For twenty years Dr. Lewis has made great contributions to the aeronautical sciences, a work which has been recognized and honored all over the world. There is little doubt but that the achievements of American aircraft and engines, both military and commercial, owes much to the contributions which Dr. Lewis has made. He has traveled all over the world and has kept continuously informed as to research progress in laboratories of England, France, Germany, Italy, and elsewhere. He gave the Wilbur Wright Lecture before the Royal Aeronautical Society in the spring of 1939. He is past president of the Institution of the Aeronautical Sciences, and in 1940 was chairman of the important Collier Trophy Award Committee.

The Committee's first employee is now its Secretary, John F. Victory, who directs the administrative work. His broad knowledge of governmental procedure and experience with Committee's policies since its creation in 1915 have been a material influence in the efficient functioning of the organization.

The office of Coordinator of Research for the N.A.C.A. was set up as of the first of January, 1940. Its primary function is to maintain close contact with all branches of the aviation industry and to establish close liaison with all organizations, both governmental and private, that have any sort of aeronautical research facilities. The Coordinator is charged with the control of funds that are set up for the support of aeronautical research in schools and universities to supplement the research programs of the N.A.C.A. and the Army and the Navy toward the improvement of our national defense. Practically every university that has any sort of facilities for research in any field that falls within the scope of activity of the N.A.C.A. has been surveyed, andefforts are constantly being made to discover research projects on which such facilities can be used most effectively.

The actual allocation of funds for the support of research in outside institutions is in the hands of the four main subcommittees. these committees cover aerodynamics, power plants, aircraft materials, and aircraft structures, and are made up of outstanding experts from Government services and from private industry. These technical groups meet frequently to consider the research needs of the Army, the Navy, and industry, and to meet those needs

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through the setting up of proper research programs, both in the Committee's laboratories and at educational institutions. It is a fixed policy of the Committee to establish special technical subcommittees reporting to the four main committees, to study particular problems as they may arise. For example, the Aerodynamics Committee has under its wing subcommittees on airships on seaplanes, on vibration and flutter problems, and on meteorological problems. Under the Power Plants group come special subcommittees on fuels and lubricants, superchargers, etc. Two special subcommittees report to the Committee on Aircraft Materials, dividing the field between metals used in aircraft and all other miscellaneous materials. Within the scope of the latter group come such important considerations as the development of plastics for aircraft, new fabrics, paints and finishes, and a host of miscellaneous items. The Committee on Aircraft Structures has two major subdivisions, one working on problems of direct research in applied structures, and the other determining techniques for making elastic examination of large aircraft structures in lieu of destruction tests.

The Above are committees of long standing. From time to time special jobs come along that need Committee attention, and groups are set up to study them. For example, groups have been organized to study sites for the location of new laboratories, or problems relating to accident investigations, etc.

It is largely through the work of the technical subcommittees that industry and governmental personnel are given the opportunity to sit down around the same table and discuss in detail problems that relate to the improvement of aircraft, engines, and accessories. Both the Director of Research and the Coordinator of Research are members of all committees, to insure that there is no duplication of effort within or without the organization of the N. A. C. A.

The main laboratories of the Advisory Committee are located at Langley Field, Virginia. Langley has long been the standard against which aeronautical laboratories all over the world have been compared. From a modest beginning in 1917, they have grown to the point where they include practically all known forms of research equipment. The staff now numbers over 750 technicians. Approximately 12 million dollars has been invested to date.

At the present time the Langley laboratory consists of the following units:

8-foot 500-mile-an-hour wind tunnel
Full-scale wind tunnel with a throat 60 x 30 feet
19-foot pressure tunnel
3 x 7½-foot refrigerated wind tunnel
2-dimensional flow tunnel
Stability tunnel
16-foot high-speed tunnel
20-foot free-spinning tunnel
20-foot propeller research tunnel
5-foot variable density wind tunnel
7 x 10 foot wind tunnel
4 x 6-foot vertical wind tunnel
15 foot free-spinning wind tunnel
19 12-foot free-flight tunnel

Two high-velocity jet type tunnels 11 x 24 inches, respectively

2900-foot towing tank

Engine research laboratory

Structural research laboratory

Instrument laboratory

Flight research laboratory

A large administration building houses the executive and part of the engineering personnel, and to take care of model building, repairs, and maintenance, complete shop facilities have been installed.

Extensive as are the facilities at Langley Field, it became apparent long ago that they were not adequate to meet the rapidly growing needs of our defense program. In 1939, Congress authorized the establishment of a second aeronautical research laboratory at an estimated cost of 10 million dollars. After looking over some 54 sites for the proposed laboratory, it was decided to locate it at Moffett Field in California.

The site consists of approximately 100 acres, located on a large flying field, formerly a naval air station and now used by the Army Air Corps. The Committee will conduct research activities of a similar nature to those which are handled at Langley Field. Wind tunnels and flight research facilities are already well under construction and by the fall of 1940 a substantial part of the research staff necessary to operate them had been assigned and moved to their new location.

19 Fittingly enough, the Moffett Field station has been named in honor of the man who served for many years as Chairman of the

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N.A.C.A., Mr. Joseph S. Ames. Thus, the Ames Aeronautical Laboratory and the Langley Memorial Aeronautical Laboratory stand in recognition of the work accomplished by two great pioneers of American aeronautical research.

Acting on the recommendation of a special investigating committee, headed by Colonel Charles A. Lindbergh, Congress, in the Summer of 1940, appropriated funds for the construction of a third research laboratory, whose sole purpose would be to conduct investigations to prove the performance of American aircraft engines. Although engine research has been conducted at Langley Field for many years,-work which has been of tremendous value to engine designers, -it became apparent that the vastly increasing national defense program called for a considerable expansion of research in the power plant field. It was felt that the work was of sufficient importance to warrant the establishment of a separate laboratory. Eight million, four hundred thousand dollars have been allotted for this job and work is now in progress on the selection of a site and on the organization of a staff to man it. There is nothing in the field of engine performance or design, or on fuels and lubricants, and accessories, that will not come in for detailed experimentation at the new station.

The tremendous advance that has taken place in the performance of aircraft and engines during the past twenty years is the direct result of laboratory experiment. A great deal of it has come about from practical experience in the field, but it is safe to say that it could not have been as rapid nor have been carried on as economically had it not been for the fundamental work of the N.A.C.A. in its wind tunnels, towing basins, and engine laboratories.

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At the end of the war in 1918, the best pursuit airplanes could do a bare 120 miles an hour. Bombers with top speeds of 80 to 90 miles an hour could fly with very limited loads only 200 to 300 miles. Today all governments write specifications for fighter aircraft on a 400-mile-an-hour, or better, basis, while bombers from 300 to 350 miles an hohr carry tons of useful load over thousands of miles non-stop. Progress of this sort has only one major source, - continual research.

Ten years ago our transport airplanes were slow, noisy, uncomfortable, and uncertain. One hundred and twenty miles an hour was a good cruising speed. Passengers got along as best they could in narrow uncomfortable seats, with little in the way of comforts and conveniences. The safety record left much to be desired. Structural failures in flight were not uncommon, and engine failures were frequent.

Today we travel comfortably at 200 miles an hour. The modern air liner is an outstanding achievement in comfort, convenience, and safety. In 1940, the air lines of the United States established a remarkable record, when for a period of 17 months they flew millions of passenger miles swiftly, comfortably, and without interruption, without a single fatality to passengers or crew. No other transportation system in the world has ever equaled such a record.

All this has come about largely as the direct result of research - not only scientific research on fundamental problems in Government laboratories but also applied research by the engineers of our manufacturing plants that produce the airplanes and the engines, and constant observation and search for improvment by the engineering operations and maintenance departments of our military services and air lines. We do not ordinarily class maintenance men and meteorologists as research personnel, but their contributions made from experience in daily flights and from daily observation and compilation of data, are of great importance.

In these fields cooperation has been the keynote. Ten years ago pilots and the maintenance and operating personnel of one air line seldom cooperated with those of another. There was an atmosphere of mutual suspicion and distrust, which was fostered by the competitive situations of the period. As time went on, however, these poeple discovered the great advantage of meeting frequently and pooling their information. One of the greatest contributions to practical research in the cause of air safety has been made by the Inter-Airline Maintenance and Engineering Committee, an organization which meets twice a year. Under the auspices of the Air Transport Association of America they swap ideas on equipment and equipment maintenance. Representatives of the Army Air Corps, the Bureau of Aeronautics of the Navy, the Civil Aeronautics Authority, and the National Advisory Committee for Aeronautics are always invited to be present. The

Coordinator of Research, N.A.C.A., has been an honorary member of the Maintenance Committee for many years.

The outstanding characteristic of all aeronautical research in America has been its increasing effectiveness through cooperation. By having representatives of industry and of the Government meet frequently and pool ideas, our research efforts are kept at maximum effectiveness, both for the development of our commercial and our military aviation. No stones are being left unturned to insure that American aeronautics holds its proper position in the forefront of the world.

MESSAGE OF THE PRESIDENT.

To the Senate and House of Representatives:

I transmit herewith for the consideration of the Congress, the Third Annual Report of the National Advisory Committee for Aeronautics, including a statement of the expenditures to June 30, 1917.

The estimates of the committee, together with its plans for enlarged activities contemplated through its laboratories and scientific staff at Langley Field, outlined in the closing paragraphs of the report, have my hearty approval.

The attention of the Congress is also invited to the request of the committee that the appendixes to its report be published with the report.

WOODROW WILSON.

THE WHITE HOUSE, *December 7, 1917.*

This appropriation became immediately available upon the passage of the act, and, added to the continuing appropriation of $5,000 a year for five years, carried in the act establishing the committee, made a total of $112,000 available for the fiscal year 1918.

In order to provide funds for the completion of the committee's research labaratory, the following amendment to the above appropriation was contained in the urgent deficiency act approved October 6, 1917:

> National Advisory Committee for Aeronautics: Such portion of the appropriation "National Advisory Committee for Aeronautics" carried in the act making appropriations for the Naval Service for the fiscal year ending June thirtieth, nineteen hundred and eighteen, approved March fourth, nineteen hundred and seventeen, as may be necessary, not to exceed $40,000, is made available for the completion of the committee's research laboratory now under construction, and for the construction of additional buildings necessary in connection therewith.

ESTIMATES FOR THE FISCAL YEAR 1919.

The following estimates of expenses for the fiscal year 1919 have been submitted by the committee in due form:

> For scientific research, technical investigations, and special reports in the field of aeronautics, including the necessary laboratory and technical assistants, traveling expenses of members and employees, rent of offices in the District of Columbia, office supplies, printing, and other miscellaneous expenses, equipment, maintenance, and operation of research laboratory, and construction of additional buildings necessary in connection therewith; purchase, maintenance, operation, and exchange of necessary airplanes and one motor-propelled, passenger-carrying vehicle; clerks; draftsmen; personal services in the field and in the District of Columbia: *Provided*, That the sum to be paid out of this appropriation for clerical, drafting, watchmen, and messenger service for the fiscal year ending June thirtieth, nineteen hundred and nineteen, shall not exceed $20,000; in all, $260,000.

CONCLUSION.

In conclusion attention is invited to the following:

1. The committee has been in existence about two and one-half years and during that time has carried through and prepared for publication 23 technical reports dealing with various phases of the science and art of aeronautics. It has further been occupied in the design and construction of its first laboratory units at Langley Field, which will be ready for occupancy early in 1918. It has further occupied itself with a great variety of questions relating to the preparations for war and with the various activities which have sprung up as a result of the existing state of war.

2. The plans contemplated for the coming year include:

(*a*) A continuance of the manifold miscellaneous activities resulting from the existing state of war.

(*b*) The completion of the first laboratory units at Langley Field and the installation of the necessary apparatus and equipment.

(*c*) The organization of a small scientific staff and the investigation of many important problems relating to the science and art of aeronautics, and with a view to their practical solution and application to the present war demands.

3. The preceding years of the committee's activities must therefore be viewed in some degree as preparatory for the more effective service which the committee hopes to render through its laboratory facilities

at Langley Field and through the enlarged technical and scientific staff contemplated in connection therewith.

4. The committee trusts that these opportunities for enlarged service, and with special reference to the present war conditions, may be found an adequate justification for the appropriation herein requested.

Respectfully submitted.

W. F. DURAND, *Chairman.*

Research-- The Price of

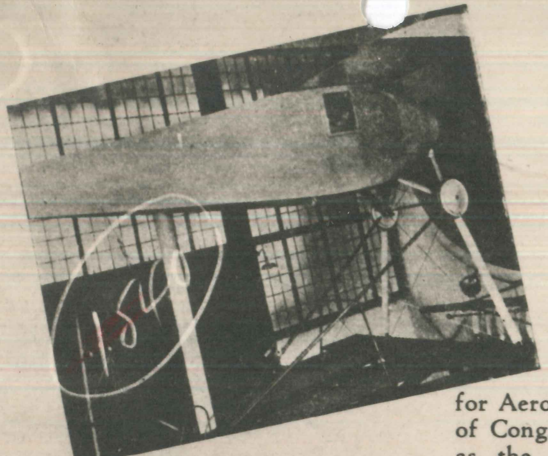


Fig. 3—Propeller drag of fuselage and cowling of Wright J-5 motor being investigated in N. A. C. A. 20 ft. propeller research tunnel.

"ETERNAL research is the price of survival." Industries falter and fail when the fundamentals or the basis on which they are established are not thoroughly and continuously investigated and conversely, continuous progress is assured when there is continuous prosecution of scientific research.

The growth of aviation has been so rapid during the past decade, and especially in the last two years, that it has been a difficult problem to organize and guide research so as to be of the greatest benefit to the industry.

In any industry research is necessary to guide it along progressive lines. Not only must research provide for steady progress to meet immediate needs, but it should anticipate and provide for the future needs of the industry. We, therefore, must have research of a fundamental character, the results of which may not be directly and immediately applicable.

The National Advisory Committee for Aeronautics was established by act of Congress approved March 3, 1915, as the government agency charged with the supervision and direction of the scientific study of the problems of flight with a view to their practical solution, and the determination of problems which should be experimentally attacked and their application to practical questions of aeronautics. The act also authorized the committee to direct and conduct research and experimentation in aeronautics in such laboratories as might be placed under its direction.

Every aeronautical engineer is or should be familiar with the service rendered by the committee through its publications known as "Technical Reports," "Technical Notes," "Technical Memorandums" and "Aircraft Circulars." The results of all important investigations and experimental research conducted by the committee are brought to the attention of aeronautical engineers, either in the form of a Technical Report or a Technical Note. The translated reports of the important investigations which are conducted abroad are presented by the committee in the form of Technical Memorandums, and the more important or more interesting new types of aircraft are described in Aircraft Circulars.

All of the committee's publications mentioned above are made available to aeronautical engineers and the industry by bulletins released at regular intervals by the committee.

The committee conducts at Langley Field, Virginia, the Langley Memorial Aeronautical Laboratory, which is considered to be one of the best equipped aeronautical laboratories in the world. In addition to the usual equipment the laboratory contains a variable density wind tunnel, a propeller research tunnel, and other smaller pieces of equipment which have not been duplicated elsewhere.

THE staff at the laboratory is engaged on research in free flight, on research in wind tunnels, and on fundamental engine investigations. The problems assigned to the laboratory are approved by the National Advisory Committee upon recommendations of its subcommittees on Aerodynamics, Power Plants for Aircraft, and Materials for Aircraft. The membership of the subcommittees is made up of men well qualified to gauge the importance and value to the industry of proposed investigations.

The most important investigations which the committee has recently undertaken that will be of particular interest to the industry are those affecting safety and economy in aircraft operation. The most critical point in an airplane flight today is the making of a safe and comfortable landing, either on water or on land. Great skill is required to land safely under all possible conditions. The airplane must be improved so that ordinary skill will be sufficient, if safety in civil aviation is to be assured. The chief factor in this problem is the nature of the air reaction upon the airplane as it assumes a landing attitude on approaching the ground. With the change in angle of attack when preparing to land, there should be no abrupt change in the lifting efficiency of the wings, or in other words, the lift curve should have a well rounded or flat top instead of the relatively sharp peak generally characteristic of airfoils in use at present.

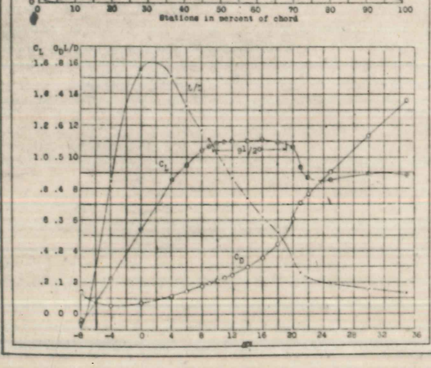


Fig. 1—Lift, drag and L/D vs. angle of attack. N. A. C. A. Airfoil No. 84. Aspect ratio—6.85.

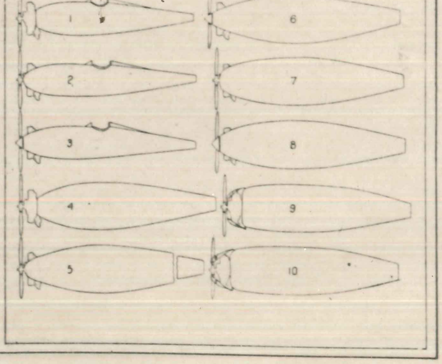


Fig. 2—Arrangement of fuselage and cowling for J-5 motor being investigated in propeller research tunnel.

By G. W. Lewis

Director of Aeronautical Research, National Advisory Committee for Aeronautics

Survival

Mr. Montgomery Knight, of our technical staff, has been working on this problem, with the result that the National Advisory Committee has developed the N.A.C.A. 84 airfoil profile. The lift curve characteristics of this profile are shown in Figure 1. As will be seen, the top of the curve has a flattened form over a considerable range.

It is also well known that a large proportion of airplane crashes may be accounted for by the sudden uncontrolled dive following a stall when close to the ground. The dive is primarily due to the relatively rapid rearward motion of the center of pressure as the angle of maximum lift is exceeded, causing a strong nosing down tendency. The characteristics of the N.A.C.A. 84 section are such that the center of pressure is very nearly stationary through the operating ranges of an airfoil in landing at from 4 to 35 degrees angle of attack. Complete data on the N.A.C.A. 84 section will be released in the form of a Technical Note.

In connection with safety in landing, airplane control is also of importance, and the committee is investigating this problem.

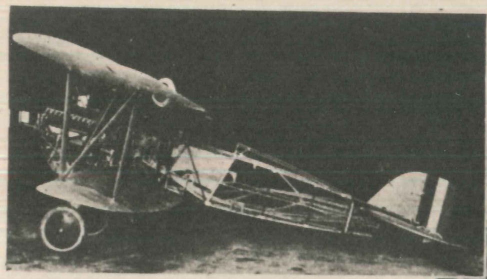


Fig. 6—Boeing pursuit plane fitted with N. A. C. A. instruments to investigate the pressure distribution over the wings and tail surface.

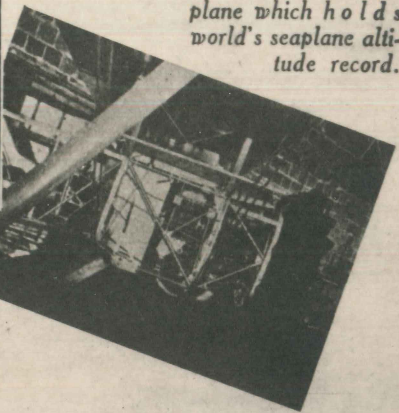


Fig. 8—Installation of Roots type supercharger in the Wright Apache plane which holds world's seaplane altitude record.

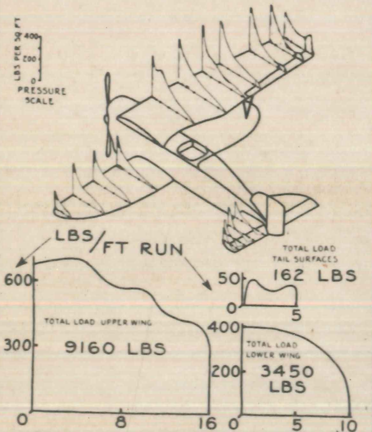
THE National Advisory Committee has in the variable density wind tunnel a piece of equipment not available anywhere else in the world. The models tested in the variable density wind tunnel are usually one-twentieth scale and are tested in air that is under a pressure of twenty atmospheres, or 300 pounds per square inch, so that the same weight of air passes by the model in tests as passes by the actual airplane in flight. The results obtained eliminate scale effect in ordinary wind tunnel tests and give a true indication of the results that will be obtained in flight.

Twenty-seven airfoils, known as the "M" series, were investigated in this tunnel. The main characteristics of the series were that they had small changes in the center of pressure movement. The M-6 section of this series has been used by a number of manufacturers, and recently two manufacturers have introduced airplanes using the M-12 section. The most recent section adopted by a manufacturer is the M-18 section which will be used in a small monoplane. The M-15 section is used in France on the "Avimeta 92" airplane. Other wing sections which have been developed by the committee and which are being used by manufacturers are the N.A.C.A. 81 and the N.A.C.A. 81-J.

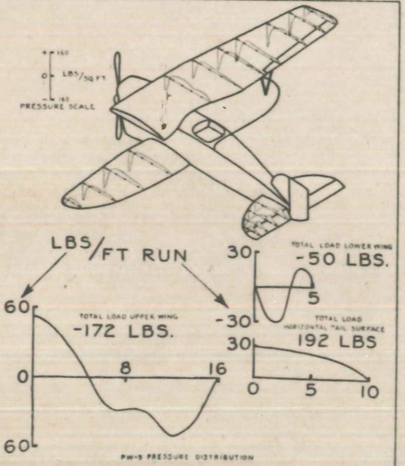
At present the most promising means of reducing the drag and increasing the economy of aircraft operation from the standpoint of power required is to design the airplane structure and the engine installation so as to give a minimum of resistance. The new propeller research tunnel at Langley Field, having a diameter of 20 feet, can accommodate a full-sized fuselage with engine and propeller. This equipment offers an excellent opportunity for studying different types of engine installation, propeller mountings, and fuselage forms, so as to give the minimum of resistance for a given fuselage size.

Figure 2 gives an outline of ten different arrangements which are now being investigated, all of which pro-

(*Continued on Page* 224)



PULL-UP AT 186 M.P.H.
PRESSURE DISTRIBUTION PW-9
FIG. 4



PUSH-DOWN AT 160 M.P.H
FIG. 5

Figs. 4 and 5—Some of the results obtained from studies of pressure distribution on a Boeing PW-9 pursuit plane.

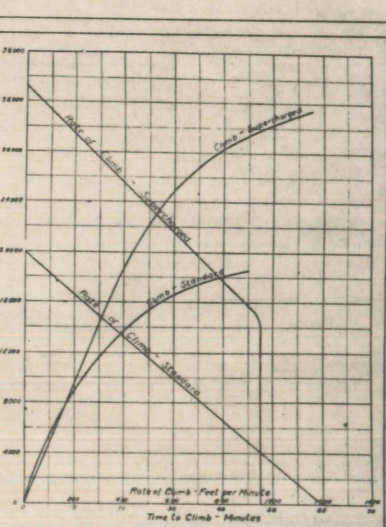


FIG. 7

Fig. 7—Advantages of supercharging a J-4 motor on Vought type plane.

Switch in Guggenheim Policy

(*Continued from page 222*)

great educational institutions, representing grants of about $1,200,000, in addition to a number of smaller grants to a number of smaller organizations.

In selecting these institutions, there were three determining factors: The engineering school must be of outstanding importance with a highly trained staff and outstanding physicists and mathematicians on its faculty; it must have a certain amount of background in aeronautics so that the enthusiasm already engendered would be a guarantee for the future conduct of the work; and the centers chosen should be so situated as to take care of the needs of different sections of the country. In the East there were the Massachusetts Institute of Technology and New York University; in the central part of the country, the University of Michigan; on the West coast, the California Institute of Technology, Leland-Stanford and the University of Washington.

Aeronautic Instruction

The response to the aeronautic instruction in these engineering schools has been extraordinary. There is an enormous demand for the courses. At New York University it was originally planned to accommodate 40 students. There are 50 in the freshman class alone today. When these men graduate, it does not seem likely that they will have difficulty in finding positions as aeronautical engineers.

Academic instruction of a more elemental kind is also the objective of the Fund's Committee on Secondary and Elementary Aeronautical Education under the chairmanship of John W. Withers, Dean of the School of Education of New York University. The committee is considering the ways and means whereby instruction in aviation can be introduced into the school curriculum in such a manner as not to disturb the existing balance and without necessarily adding a separate study to the already numerous list of courses. The Fund is cognizant of the rapidly growing importance of aviation as a feature of every-day life; it is anxious that the younger generation which will be the one most affected by these developments should be conscious of the principles and practices of aeronautics. In many instances, it will be found that the study of aeronautics is supplementary to a number of other subjects, such as science, economics, mechanics and geography. A pamphlet published by the Fund, on "Aeronautic Education" by Dr. William F. Durand, a trustee of the Fund, surveys the scope of a study of this kind.

In addition to the aeronautic instruction given at the universities mentioned above, these institutions are important factors in the Fund's program of research. Each one has, or will have, at least one wind tunnel and adequate laboratory equipment. In this work of scientific research, the Fund has also been called upon to consider literally thousands of inventions seeking support. Many of these are, of course, worthless. In conformity with its principle of confining its attention to work which otherwise might not be done, the Fund tries to divert these inventions to organizations such as the National Advisory Committee at Langley Field, the Army Air Corps and the Navy Aircraft factory.

One of the first objectives of the Fund was safety in aviation. In order to bring to light the latest devices in making the airplane a reliable machine and to stimulate other devices, the Fund organized a Safe Aircraft Competition with prizes aggregating $150,000. The doctors disagree as to what constitutes safety in an aircraft, but after a year's study and after securing the benefit of the advice of manufacturers, pilots, scientists, and others, both here and abroad, the Fund prepared a specification. Some of these specified items have been solved in individual instances on different airplanes; the Fund wished to combine them in one aircraft which might be called a "fool-proof" airplane.

The Competition is now open and will remain open until October, 1929. As the entries arrive, they will be tested at Mitchell Field and given a certain number of points. The Fund believes that a fundamentally safe aircraft can be produced, and it is encouraging to note that entries are being received from the most important manufacturers in different countries.

The Safe Aircraft Competition naturally leads to the third classification of the Fund's work, that of commercial development. The invention of a fundamentally safe airplane will itself be a vitally important stimulus to the commercial use of the airplane. Under the heading of commercial development, the Fund granted an equipment trust loan to finance the purchase of passenger carrying airplanes and thus encourage passenger transportation. It was hoped that this would demonstrate a type of financing which would subsequently be undertaken by regular banking institutions. A loan was granted to the Western Air Express for three multi-engined passenger airplanes flying between Los Angeles and San Francisco. These planes have now been in operation since the end of May and have been running on schedule with remarkable results, carrying full loads. Since the granting of the loan there has been a considerable expansion in regular passenger-carrying activity, notably by the Maddux, Boeing and Stout companies.

Weather Reporting

Similarly, the Fund is sponsoring a complete weather reporting service on the Los Angeles-San Francisco Airway for the year ending June 30, 1929, in co-operation with the Department of Commerce, the Weather Bureau, Army and Navy, and the Pacific Telephone and Telegraph Company. This route was selected due to the fact that regular passenger service is maintained over it by three air transport companies, as well as air mail service, and both the Army and Navy will carry on extensive air operations at various places along the route. Twenty-two observation stations are to report to the two terminals at Los Angeles and San Francisco, constituting a network of observation points stretching from the Pacific to the Sierras. The reports are communicated four times daily and once at night to trained meteorologists, who will forecast flight conditions for the entire area, advising the departing pilot one of several courses which should be followed, and keeping the pilot informed while in flight as to any weather changes. It is hoped that this plan will serve as the basis for the national development of the weather services to cover the entire country.

Research—The Price of Survival

(*Continued from page 73*)

vide for the mounting of the J-5 Wright Whirlwind engine. Figure 3 is a photograph of arrangement No. 4 shown in Figure 2 being tested in the 20-foot propeller research tunnel. It will be noted that the mountings vary from installations where the engine has no cowling to a fully cowled engine with open cockpits and with closed cabins. In this investigation, which is known as "the cowling and cooling of air-cooled engines," the temperatures of the cylinders at some sixty points are recorded for each particular type of cowling and for each particular type of propeller. From the results of this investigation it will be possible to determine the most efficient fuselage form and engine cowling for open-type cockpits and closed-cabin airplanes using the Whirlwind engine.

As early as 1920 and 1921, Messrs. Norton and Bacon, of the committee's technical staff, in conducting tests of pressure distribution on airplanes in wind tunnels and in free flight, found that the increase in pressure near the leading edge as compared with the pressure on the after part of the wing was so great as to make a modification in the structure of the wings desirable. This led to the leading edge of the wings of most airplanes being constructed of plywood instead of fabric.

As a further result of the pressure distribution investigations conducted by the committee, it was found that the distribution of pressure obtained with negatively raked wing tips or circular tips was much more uniform than with the square or positively raked tips.

Work on pressure distribution has been continued from year to year, both in the wind tunnels and in free flight, with repeated improvements in equipment and methods, and the results obtained have been accepted by designers and by the Army and the Navy in the formulation of design specifications.

Figures 4 and 5 show some results obtained on a PW-9 Boeing pursuit type airplane. Figure 6 shows the airplane on which the tests were made. Note the large number of tubes connecting the recording instruments with the pressure orifices in the tail surfaces.

There is no doubt that in the future commercial aircraft as well as military aircraft will find that superchargers will be necessary in flying in certain areas, especially where high altitudes must be obtained or where the landing fields are at altitudes of 5,000 feet or more. The committee, in studying performance characteristics of airplanes under supercharged conditions, developed the Roots type supercharger which is now in service in the Navy Department and which was used by Lieutenant Champion in making the world's altitude record. The advantages of supercharging are best shown in Figure 7, where it will be noted that the rate of climb of a supercharged Vought type airplane with a J-4 air-cooled engine was constant to an altitude of over 14,000 feet and the ceiling of the airplane increased from 18,000 to 28,000 feet. The installation of the Roots type supercharger in the Wright Apache airplane, which holds the world's seaplane altitude record, is shown in Figure 8.

RESTRICTED

NATIONAL AVIATION FORUM
Washington, February 20-21, 1939

AERONAUTICAL RESEARCH AND NATIONAL SECURITY

By John F. Victory, Secretary,

National Advisory Committee for Aeronautics

Man's first conquest of the air by the Wright brothers in 1903 was the result not of an accident, nor of a series of fortuitous events, but was rather the result of deliberate, painstaking research extending over a period of years. The Wright brothers examined and experimented with, and then either adopted or discarded the available technical data. When they realized that the data available were not accurate nor sufficient, they built the first wind tunnel in America; It had a throat 12 inches square and a simple balance for measuring the air forces on a model. With this scientific approach to their problem they combined the skill of the practical engineer and the courage and determination necessary for success. The science of aeronautics has advanced tremendously since that time, but the wind tunnel is still the chief instrumentality of research.

A few months after the World War started in Europe,

This is a True Copy
Dorothy C. Pyle
22 Dorothy C. Pyle,
2nd Lt. AC.
Assistant Historical Officer, FAF

THE Congress of the United States recognized that aeronautics was essentially an engineering science about which the world knew but little, and the United States even less than some European nations, which had been quicker to sense and to develop the possibilities of the airplane. So, early in 1915, the Congress established the National Advisory Committee for Aeronautics, charged it with the duty of supervising and directing the scientific study of the problems of flight, and authorized it to conduct research and experiment in aeronautics in such laboratory or laboratories, in whole or in part, as might be placed under its jurisdiction.

When, two years later, the United States entered the World War, the N.A.C.A. was constructing its first laboratory building at Langley Field, Virginia. Although the Committee was helpful in many ways to the Army, the Navy, and the aircraft industry during the war, it was not until after the war was over that its research activities really began to bear fruit. The war demonstrated some of the possibilities of the airplane and gave an enormous impetus to its development.

Although is appeared for a time that the "war to end wars" had brought enduring peace to the world, the Congress nevertheless, in the exercise of its constitutional duty to provide for the national defense, and perhaps also because it had a farsighted vision of the future of the airplane in commerce as well as in war, appropriated funds year after year for the development of the research laboratories of the N.A.C.A. at Langley Field, Virginia.

In placing the function of aeronautical research in an independent scientific agency of government composed of representatives of the governmental agencies concerned, and also of distinguished scientists serving without pay, and in consistently supporting the reommendations of that body, the Congress in large measure becomes entitled to credit for the remarkable progress that has been made in American aeronautics as a result of the continous prosection of organized scientific research on the fundamental problems of flight.

For more than ten years prior to 1938 the United States led in the technical development of aircraft, largely as a result of consistent adherence to a sound policy that recognized scientific research as the foundation for technical progress. The Army, the Navy, and the industry relied on the N.A.C.A. for the solution of fundamental scientific problems, which increased in importance and difficulty with each increase in speed or size of aircraft. The importance of conducting aeronautical research on a comprehensive basis was first appreciated generally by European powers in 1932. From that time on, increasing emphasis has been placed on the establishment of research laboratories abroad and upon the training of research personnel. In Germany to-day there are four major research centers, one of which at Adlershof has four times the personnel of the single N.A.C.A station at Langley Field. Germany has thus laid the foundation for supremacy in the technical development of aircraft. In the past few years German laboratories have produced fundamental information that has resulted in the present superior preformance of certain types of German military aircraft. Italy has constructed an entirely new city of Guidonia, devoted exclusively to aeronautical research. In view of the increasing significance of aviation for purposes of transportation and the present overshadowing influence of air power in world affairs, the United States in entering upon a new era of aeronautical development.

In planning for an enlarged program of Government aviation activities careful consideration should be given to a number of controlling factors. Of first importance is the fact that aeronautics, as an engineering science, is rapidly growing and expanding. New information and new developments are forthcoming every month, and the prospect for fu-

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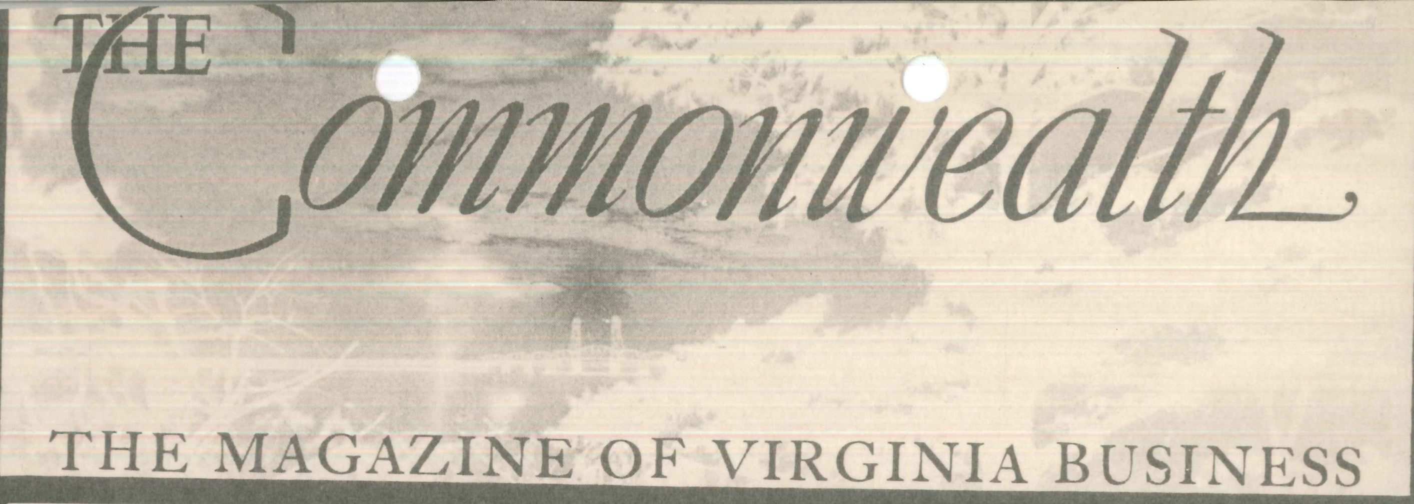
ture developments affecting the efficiency and speed of aircraft in the light of present research lends added importance to the air problem. In view of the rapid advance in the science of aeronautics, one thing is certain to happen with reference to aircraft that are already built or building, and that is to hasten their obsolescence.

A national air program should therefore be based on strengthening the foundations of aeronautical progress by expanding the aeronautical research facilities of the N.A.C.A. and the experimental engineering facilities of the Army and Navy. These go hand in hand, and both are essential to enable the development of aircraft of maximum attainable performance for national defense. Unless the research facilities of the N.A.C.A. and the engineering development facilities of the military services are enlarged sufficiently to meet the accelerated progress abroad, the proposed investment in an expanded aircraft program will have disappointing results. In time of war superior performance may be of greater value that superiority in numbers.

To meet the situation, the President has recently submitted to the Congress a special recommendation for material expansion in the research facilities of the N.A.C.A., including additional facilities at Langley Field and the establishment of a second major research station on the West Coast. The plan also provides for the more effective coordination of research in and with the industry, and for the stimulation and encouragement of research in educational and scientific institutions. With adequate provision for scientific research and increased support for military experimental engineering underlying a broad general plan for strengthening the air defense of the nation, the country can be assured of maximum progress. Unless there is such expansion in research facilities, it is the expressed belief of the N.A.C.A. that the United States will definitely fall behind.

In view of the tremendous influence of air power in the present critical condition of world affairs, and the increasing importance of international trade routes of the air, it is vital to proceed with this program without delay. On its execution will largely depend the success of the Army, the Navy, and the industry in their efforts to develop military and commercial aircraft that are at least equal in performance, effience, and safety to the best that may be developed abroad.

To the extent that air strength is essential to national security in the years that lie immediately ahead, the expansion of research facilities is essential to assure the effectiveness of the air program. Thus can we best provide the constant supply of new knowledge necessary to regain leadership in airplane development and to keep America first in the air.



THE Commonwealth

THE MAGAZINE OF VIRGINIA BUSINESS

VOLUME II DECEMBER, 1935 NUMBER 12

Aeronautics Research

By EDWARD R. SHARP[1]

MASTHEAD PHOTO: *James River Bridge, at Newport News*

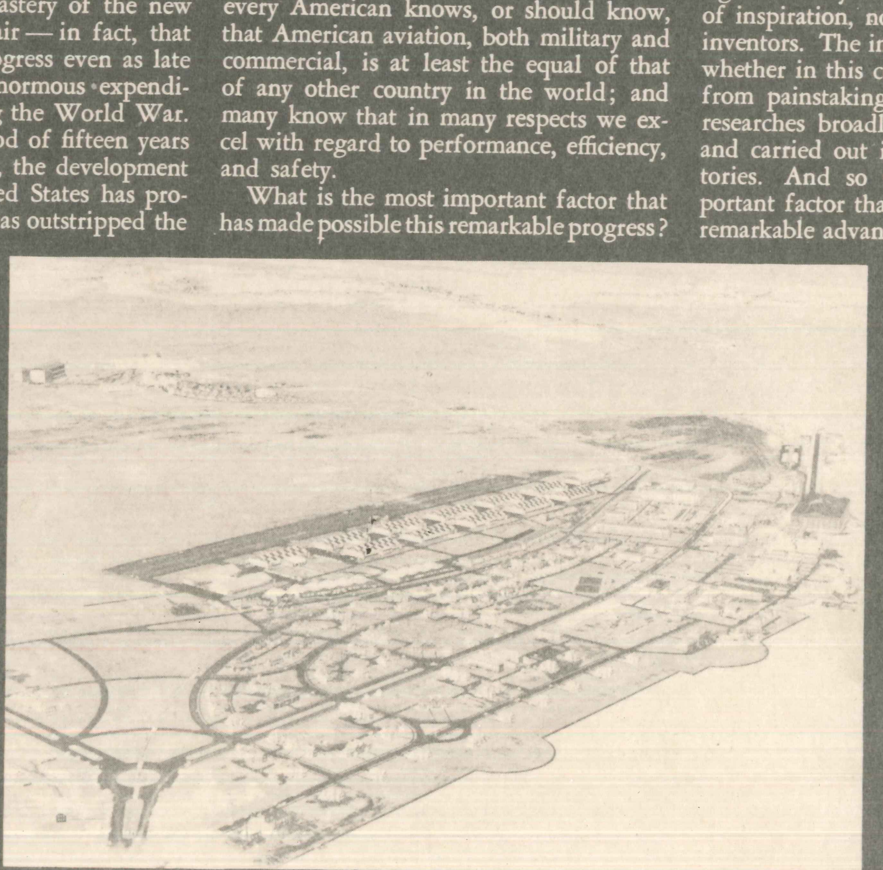
EVERY American knows that the first successful flight of an airplane was made on American soil, at Kill Devil Hill, near Kitty Hawk, North Carolina, in 1903. Well known also is the fact that for the next dozen years Americans made little advance in the mastery of the new art of navigating the air — in fact, that they had made little progress even as late as 1920, in spite of enormous expenditures on aviation during the World War.

However, in the period of fifteen years between 1920 and 1935, the development of aviation in the United States has progressed at a rate which has outstripped the prophecies of even the most enthusiastic prognosticators. In that period we have seen a most rapid improvement in American aeronautics, both as to performance of airplanes and extent of operations. American commercial aviation has far outdistanced that of any other country in the world, reversing its standing of ten, fifteen, twenty years ago. Today, every American knows, or should know, that American aviation, both military and commercial, is at least the equal of that of any other country in the world; and many know that in many respects we excel with regard to performance, efficiency, and safety.

What is the most important factor that has made possible this remarkable progress?

It is not luck, and it is not accident, that has brought about this remarkable advance. Better airplanes do not just naturally grow, nor do they spring full-fashioned from the hands of the designers. They are not the result of flashes of inspiration, nor the product of chance inventors. The improvement of airplanes, whether in this country or abroad, comes from painstaking and thorough scientific researches broadly and soundly planned, and carried out in well-equipped laboratories. And so it is that the most important factor that has made possible the remarkable advance in American airplanes is the fundamental scientific aeronautical research conducted by the National Advisory Committee for Aeronautics in its laboratories in Virginia at Langley Field, near Hampton.

The National Advisory Committee for Aeronautics, better known in the United States by its initials N.A.C.A., and in Europe by the word "Naca," is an independent branch of the government, reporting to the Congress through the President, and financed entirely by congressional appropriations. The Committee was



Langley Field, near Hampton

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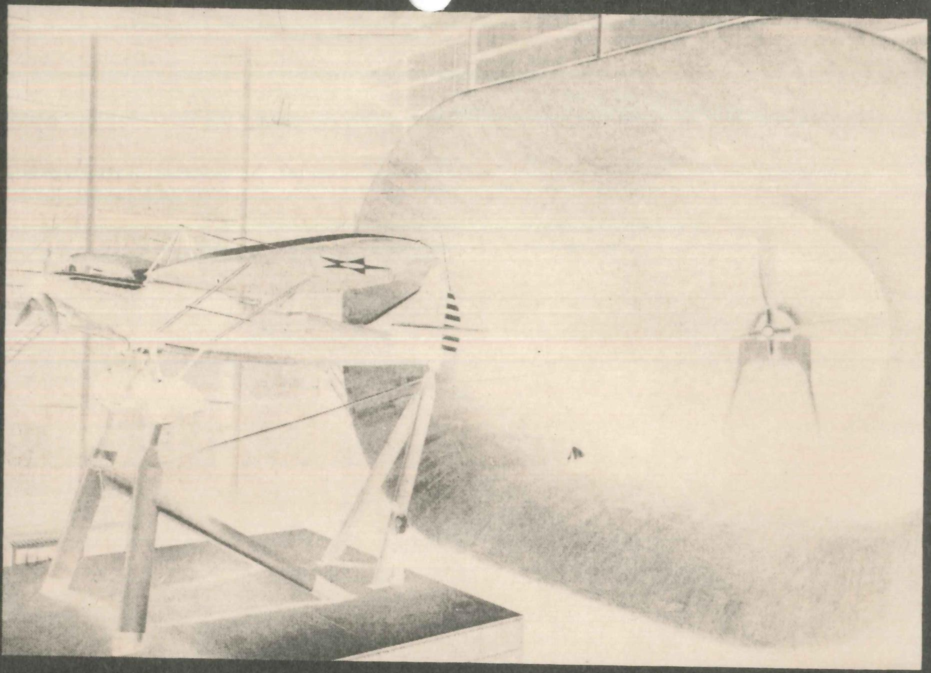
[1] Chief, Administrative Division, National Advisory Committee for Aeronautics, Langley Memorial Aeronautical Laboratory, Langley Field, Hampton.



Full-scale wind tunnel, largest wind tunnel in the world

established by act of Congress in 1915 as an independent establishment, to direct and conduct fundamental scientific research in the problems of flight. It consists of fifteen members, appointed by the President, who serve on the Committee without compensation; two members each from the Army Air Corps and the Naval Bureau of Aeronautics, one each from the Bureau of Standards, the Smithsonian Institution, and the Weather Bureau, and eight, skilled in aeronautical science or acquainted with its needs, selected from civil life. The members direct the policies of the N.A.C.A.

The research programs of the Committee are formulated and directed by a number of subcommittees, whose membership is composed of civilian and military experts who serve without pay. Problems in the fields of aerodynamics, thermodynamics, and hydrodynamics are referred by these respective committees to the research staff of the N.A.C.A. laboratories at Langley Field for study and report.

The main offices of the N.A.C.A. are at Washington. A European branch is maintained in Paris for the purpose of gathering information regarding European developments in both the commercial and the military branches.

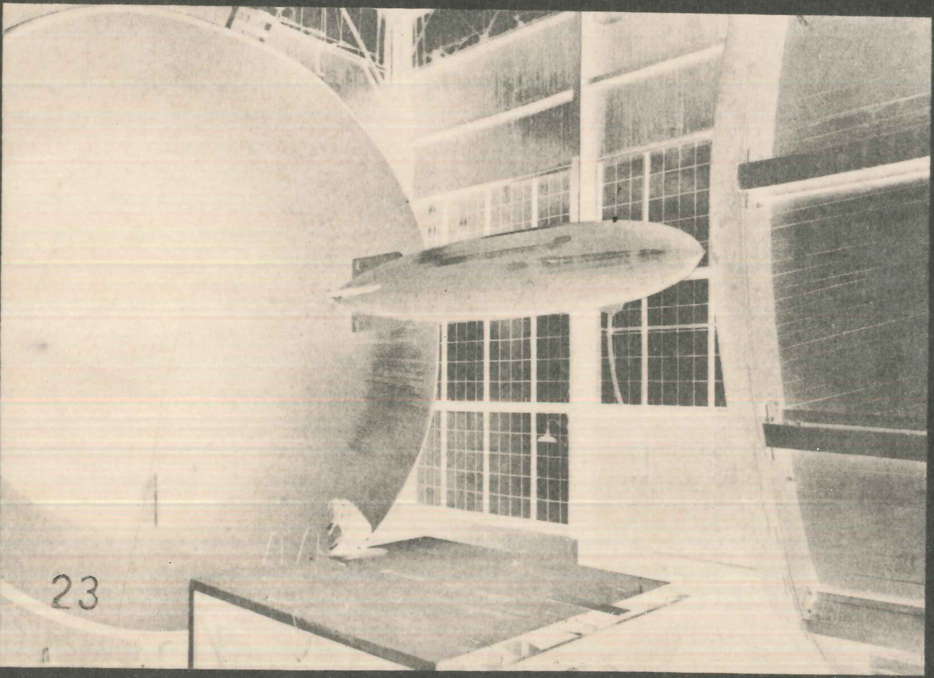
At Langley Field the Committee has built, equipped, and staffed the finest aeronautical research laboratories in the world, known as the Langley Memorial Aeronautical Laboratory. At this laboratory have been developed new and unique equipment and methods which enable its scientific staff to study and learn the controlling effects of natural laws governing the flight of aircraft.

Numbered among the pieces of extensive research equipment at the laboratories are some twelve wind tunnels, including, among others, a compressed-air wind tunnel, a super high-speed wind tunnel, a free-spinning wind tunnel, a refrigerated wind tunnel, a propeller-research tunnel, a smoke-flow tunnel, and a full-scale wind tunnel. Under construction is a new wind tunnel capable of testing models at 500 miles an hour. The N.A.C.A tank, a towing basin for studying the performance of models of seaplane floats and flying-boat hulls, is 2,000 feet long and its carriage attains a maximum speed of sixty miles an hour; it is the longest and fastest naval tank in the world.

Supplementing the wind-tunnel and tank equipment is a well-equipped flight research laboratory where investigations are carried out on airplanes in flight. In the newly constructed power plants laboratory are conducted investigations with respect to engines and accessories. Well equipped mechanical shops, physical laboratories, and an administrative building round out the facilities of the laboratory.

The laboratories were started in 1918, with a staff of five employees and one building. The first wind tunnel was completed in 1920, and the growth of the plant has been steady up to the present time. The growth of the staff has kept pace with the growth of the plant, with the exception of two or three years during the depression. During the past few months the staff has been augmented considerably. The staff numbers more than 300, drawn from more than three-fourths of the states, and forms a group that is socially and economicaly important to the community of the lower Peninsula. The value of the N.A.C.A. plant is close to $5,000,000 and the payroll totals more than $750,000.

Conspicuous among the Committee's outstanding researches have been studies of the pressure distribution over the wings, fuselage, and tail surfaces of various types of military and commercial airplanes; an investigation of engine cowlings, resulting in the development of the N.A.C.A. cowl; investigation of the location of engine and propeller with reference to the wings of an airplane; a study of the problem of ice formation on airplane wings; and an extensive program of investigation of fuel-injection engines, commonly known as Diesel engines, with a view to the production of data necessary for the design of high-speed fuel-oil en-



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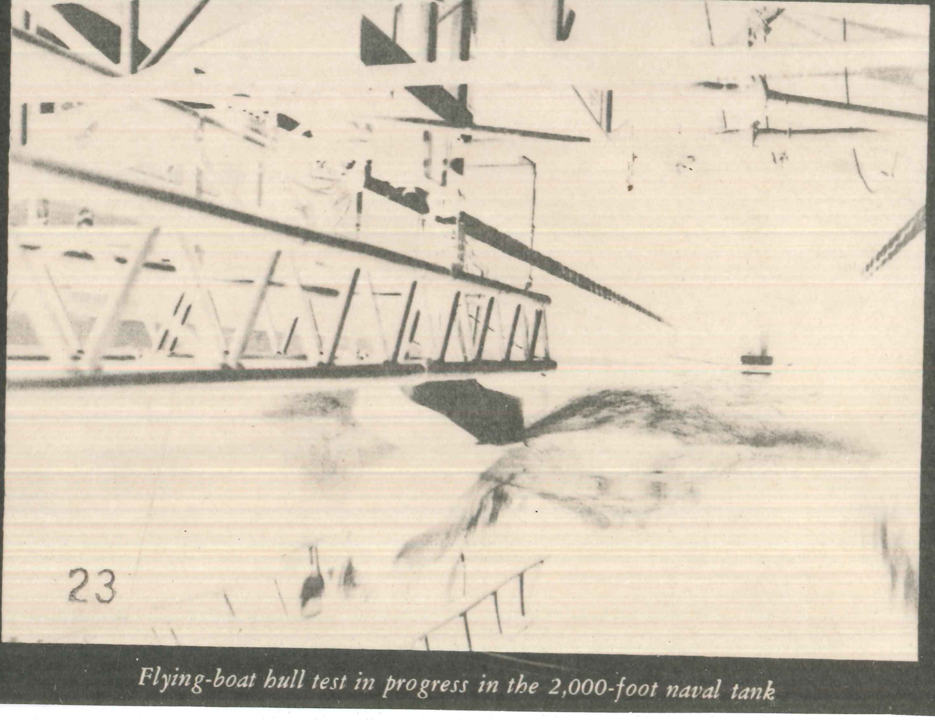
Propeller-research tunnel, with model of the "Akron" gines for aircraft.

The results of the Committee's investigations are made immediately and exclusively available to the military and naval services of the United States, and, when they have served their confidential purposes, are then released to the aircraft manufacturers and to the public generally.

The researches of the Committee lead to material improvement in the performance, efficiency, and safety of aircraft. No money estimate can be placed on the value of superior performance of aircraft in warfare, for aerial supremacy is quite likely to be ultimately decisive of a war; nor can a money estimate be placed on the savings in life and property due to improved safety in the operation of both military and civil aircraft. The value in dollars and cents of improved efficiency in aircraft resulting from the Committee's work can, however, be fairly estimated. The results of six researches completed by the Committee within the last few years show money savings several times in excess of the annual appropriations for the Committee.

In order to acquaint the aircraft industry with the facilities and the work of the Committee and to afford the industry an opportunity to present its problems to the laboratory for investigation and study, the Committee holds in May of each year an annual Aircraft Engineering Research Conference, which is attended by leading aeronautical engineers, manufacturers, and government aviation officials. Throughout the year many hundreds of other visitors from all over the United States, and, likewise from other parts of the world, come to Langley Field to visit the laboratories and inspect their equipment.



Flying-boat hull test in progress in the 2,000-foot naval tank

Henrico Tries A Business Government —and Likes It

By J. STUART WHITE[1]

IN YEARS TO COME, November 5, 1935, will most probably be looked upon by Virginia historians as a turning point in the battle for better county government in Virginia.

It was on this date that Henrico county's citizens went to the polls and, in the parlance of modern football, scored a winning touchdown for the new county manager form of government, which had then only been in existence in the county for a little more than a year.

PRIOR TO MARCH 1, 1934, HENRICO WAS governed by what is today commonly called "the old board of supervisors" form of government. It was essentially the same government which was in force in the days of the horse and buggy, when a trip to the courthouse was an event of importance in the life of the farmer and one likely to consume half a day, perhaps more.

The board of supervisors consisted of four members, one from each district, and each was elected by voters in his district. These supervisors were not unlike county supervisors in general. Engaged as they were in farming or other private occupations, they had only a limited time to give to their positions as supervisors. Many of them, through a sense of duty and a serious desire to do a good job, often sacrificed time from their private occupation to perform administrative work which should, by its nature, have been delegated to others.

The responsibilities of the governing board in Henrico increased as more and better roads were demanded and as more and more services were required by the people. Yet, despite changing needs, little effort was made to modernize the government so that it could keep pace with the times.

Consequently, we find that as recently as 1932 each supervisor had his own road force and equipment. One supervisor was actually designated by the board to handle all poor relief and he did it on his own time and himself acted as case worker.

The budget was made up in recent years by the treasurer, the key politician of the county, who, incidentally, was paid extra for this service.

There was no one person in authority, and citizens who endeavored to place responsibility were only too often given the "run around," for it was rather easy to "pass the buck" and get by with it.

As an example of county functioning under the old order, let's take a look at the school board. This board, which appointed the superintendent of schools, was named by the county electoral board, which, in turn, was chosen by the judge of the circuit court, who was elected by the legislature. Thus, the schools were linked into a political tie-up which ran to the legislature itself. Educational policies and trends were too often fixed by the calculating minds of politicians and not by men with a broad, educational background and with a genuine, sympathetic, and unselfish interest in the growth and development of children along the most advanced educational lines.

Inauguration of the county manager government in Henrico changed the method of selecting school board members, placing their appointment in the hands of the supervisors.

But to show what citizens in another county think of the old system, under which they are now living, the following is quoted from a resolution passed by the Alleghany County Taxpayers' Association on November 16, 1935:

"The present plan of naming the members of our county school boards in Vir-

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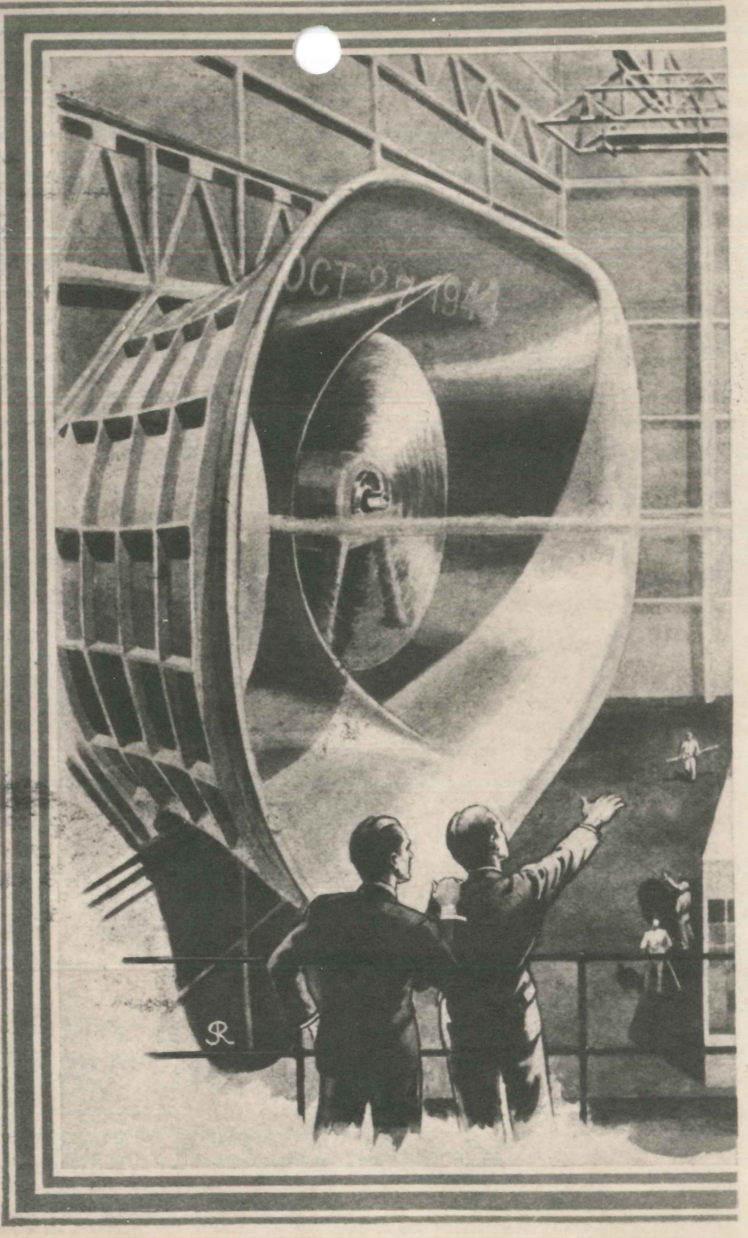
[1] Reportorial staff, *The Richmond News Leader*.

FASTER, SAFER PLANES DEVELOPED IN

Biggest Wind Tunnel

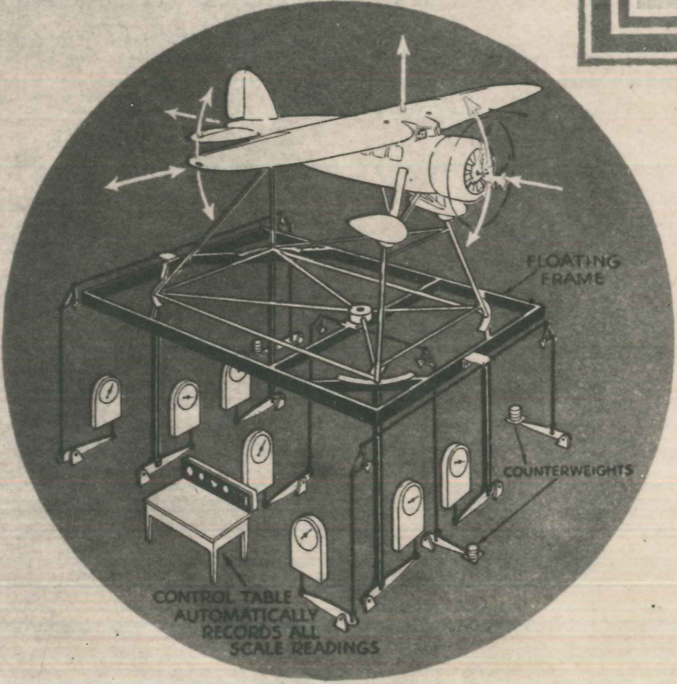


SPEED with safety in the air. Speed with economy of operation. Speed with comfort for air travelers. For the past few years these speed demands have been insistently made by the users of airplanes and especially by the airline companies whose existence depends on the swift, safe, dependable, and economical transportation of passengers, mail, and express.

The builders of commercial airplanes are meeting this demand so successfully that the operating chief of an important air-transport line tells me that his ships never wear out—that they are replaced by faster planes while they are still in excellent shape.

A year ago there wasn't a multi-motored transport plane manufactured that had a rated speed of more than 150 miles an hour.

Today the Douglas DC1 Airliner, carrying a pay load of twelve passengers and more than 1,000 pounds of cargo, has a top speed of 240 miles an hour, and an economical cruising speed in excess of 200 miles an hour. The Boeing 247 Transport, carrying a pay load of 2,400 pounds, has a cruising speed of 171 miles an hour. The new Curtiss Condor biplanes, that soon will go into service, have a high speed of 170 miles an hour, and a cruising speed of about 150 miles when carrying 3,200 pounds of revenue-producing load. The Martin B-10 monoplane, an adaption to commercial use of the Martin military ship, is another of the superfast transport planes now on the market. The Martin military plane, which can do 200 miles an hour while carrying a ton of bombs, won for its creators, in 1932, the Collier Trophy awarded to the year's outstanding achievement in aviation.



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Cut-away view of room containing instruments that automatically record lift, drag, and force of cross winds as artificial gale buffets plane. Position of the recording dials is clearly shown in the illustration

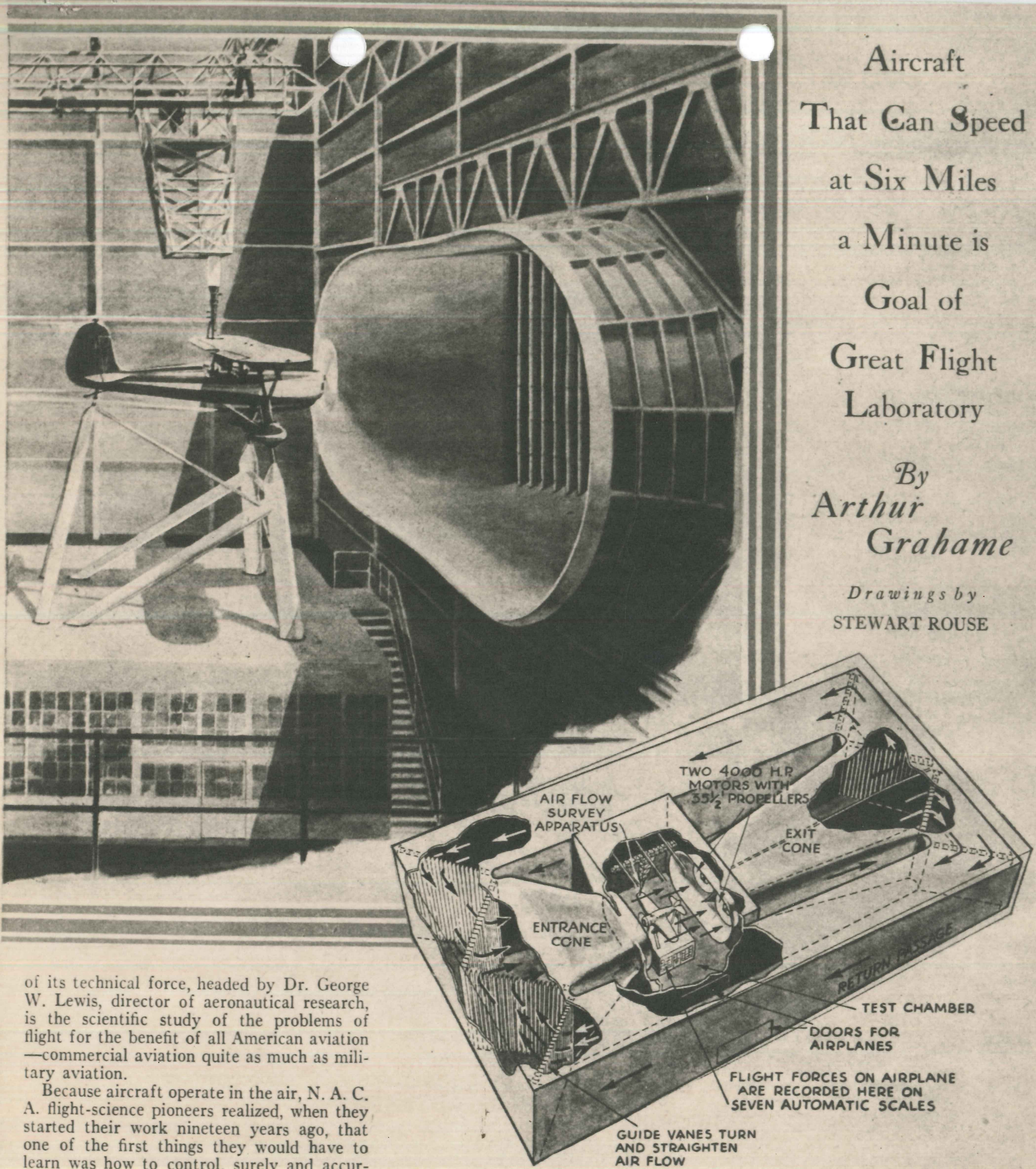
In developing today's high-speed commercial planes the manufacturers have not built ships with bigger engines to be operated at higher costs. Nor have they sacrificed airworthiness or comfort. They have achieved increased speed by turning out planes of improved design and increased aerodynamic efficiency. In doing that they have followed the trail blazed by the air scientists who work patiently for the advancement of aviation in the marvelously equipped Langley Memorial Aeronautical Laboratory of the National Advisory Committee for Aeronautics.

The N. A. C. A. has its executive offices in the Navy Building in Washington, and its laboratories, workshops, and hangar on the Army Air Corps post at Langley Field, near Norfolk, Va. It is, however, an independent government organization. Its fifteen members are appointed by the President of the United States and serve without pay. The job

Aircraft That Can Speed at Six Miles a Minute is Goal of Great Flight Laboratory

By
Arthur Grahame

Drawings by
STEWART ROUSE


TWO 4000 H.P. MOTORS WITH 35½' PROPELLERS
AIR FLOW SURVEY APPARATUS
EXIT CONE
ENTRANCE CONE
RETURN PASSAGE
TEST CHAMBER
DOORS FOR AIRPLANES
FLIGHT FORCES ON AIRPLANE ARE RECORDED HERE ON SEVEN AUTOMATIC SCALES
GUIDE VANES TURN AND STRAIGHTEN AIR FLOW

At top of page, the home of the world's biggest wind tunnel. A full-size plane is tested in the path of a gale that sweeps out of the tunnel at 118 miles an hour and is carried away by the opening at left. Above, cut-away view of tunnel showing course of the air

of its technical force, headed by Dr. George W. Lewis, director of aeronautical research, is the scientific study of the problems of flight for the benefit of all American aviation —commercial aviation quite as much as military aviation.

Because aircraft operate in the air, N. A. C. A. flight-science pioneers realized, when they started their work nineteen years ago, that one of the first things they would have to learn was how to control, surely and accurately for experimental purposes, the most elusive of the elements.

Of course, much could be learned from actual flight. Ingenious and highly accurate instruments were developed to measure and record speeds, pressures, and the positions of control surfaces while an airplane is flying. But flight tests could not solve all the problems of aviation. So a five-foot wind tunnel was built at Langley Field. In it small-scale airplane models, or full-size small parts of planes, could be mounted on delicate scales and balances, subjected to a blast of air that simulated the conditions of actual flight, and pressures and strains measured.

Later on, other and much-improved wind tunnels were built. There are a dozen of them now. A vertical tunnel is used to study the spinning characteristics of small-scale models of various types of planes. There is a steel-tank-enclosed, variable-density tunnel in which models are tested in air that is compressed in inverse proportion to the model's scale. For example, a one-twentieth-size model is tested under twenty times normal air pressure. Means for studying and preventing the formation of ice on airplanes are studied in a refrigerated tunnel. A twenty-foot tunnel, with an air speed of 110 miles per hour, is used for the full-scale testing of propellers, and also of the other parts of the plane, including fuselage, engine, landing gear, and tail surfaces.

Newest, and most impressive, is the full-scale tunnel, the world's largest, in which may be studied and measured accurately the flying characteristics of a complete full-size airplane, and in which engine and cowling problems may be investigated under conditions similar to those of actual flight.

At first glance the big structure that houses this gigantic apparatus looks as if it was built inside out, for the structural steel frame is *outside* the cement-asbestos sheets that form its walls. Of course, there has been no mistake. This building, 434 feet long and 222 feet wide, was designed to withstand wind blasts of hurricane force rushing through the inside of it.

Standing in the lofty test chamber of this house of the winds, I saw, far above my head, the mouth of a smoothly planked elliptic cone sixty feet wide and thirty feet high. Directly opposite it, and fifty-six feet away, is a similar cone, split by a smooth fairing into two circular passages. In each of these passages is mounted a four-blade, cast-aluminum-alloy propeller thirty-five feet, five inches in diameter driven by a 4,000-horsepower electric motor.

Beyond the propellers the circular passages gradually change their shape and grow larger, until at the end of the building they are forty-six feet square. At their ends series of wind vanes, that look like airplane wings set on end, are adjusted carefully to turn the airstreams smoothly into the fifty-foot-wide return passages that run the length of the building. At the other end more vanes turn the airstreams again, so that they join in the 110 by 72-foot entrance cone that narrows gradually to sixty by thirty feet at its mouth.

In the big test chamber, between and beneath the gaping mouths of the wind cones, stands a glassed-in control room, its roof about level with the lower lips of the cones. Struts, protected by streamlined fairings attached to the roof, protrude from the roof of the control room. On them is placed a plane ready for testing in the artificial hurricane.

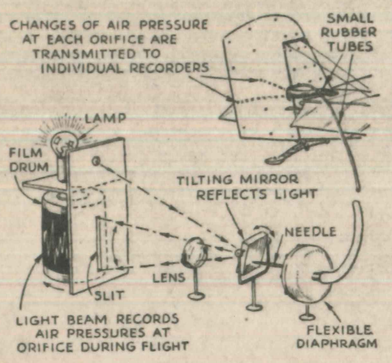
Inside the control room, protected from wind currents, is the balance that measures the air forces to which the plane under test was subjected—a balance large enough to weigh a big airplane, and yet delicate enough to serve as a postal scale.

The struts on which the axles of the plane were mounted, and the triangular frame to which its tail was attached, are secured, inside the control room, to a turntable attached to a floating frame resting on struts that transmit the lift forces to four scales. A linkage attached to the floating frame, and acting against a counterweight, transmit the drag forces to another scale. Two other linkages, attached to the frame at its front and back, and also working against counterweights, transmit the cross-wind forces to two other scales. The turntable allows the airplane to be yawed from twenty degrees left to twenty degrees right, and the frame on which the plane's tail rests can be raised or lowered, altering the wings' angle to the airstream.

With everything ready for a test, the flight scientist in charge pushed a controller handle. The big propellers began to purr. A brisk breeze leaped across the test chamber. He pushed the handle over another notch. The wind began to howl and soon reached full gale force. The dials of the seven scales were registering its pressure on the plane. The operator pushed a button, and the reading of each scale was recorded. He pushed the controller handle over another notch, and then another and another, until a mighty blast was roaring across the test chamber at the hurricane speed of 118 miles an hour.

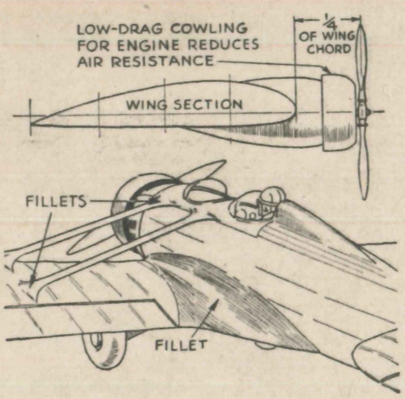
Inside the control room the air forces acting on the stationary plane from three directions, much as they would in high-speed flight, were being registered by the dials of the scales, which also recorded the intensity of the rolling, pitching, and yawing tendencies about the plane's three axes. Outside, stationed in a car mounted on a movable bridge above the path of the man-made hurricane, another engineer was intent on measuring, with a delicate instrument suspended from the car, the air flow around the plane. Much of value has been learned through this method of studying the downwash behind the wings and the air flow around the tail surfaces of planes.

~~Not all of [illegible]~~ ~~(Continued on page [illegible])~~


CHANGES OF AIR PRESSURE AT EACH ORIFICE ARE TRANSMITTED TO INDIVIDUAL RECORDERS
SMALL RUBBER TUBES
LAMP
FILM DRUM
TILTING MIRROR REFLECTS LIGHT
NEEDLE
LENS
SLIT
LIGHT BEAM RECORDS AIR PRESSURES AT ORIFICE DURING FLIGHT
FLEXIBLE DIAPHRAGM

Measuring Air Pressure in Flight

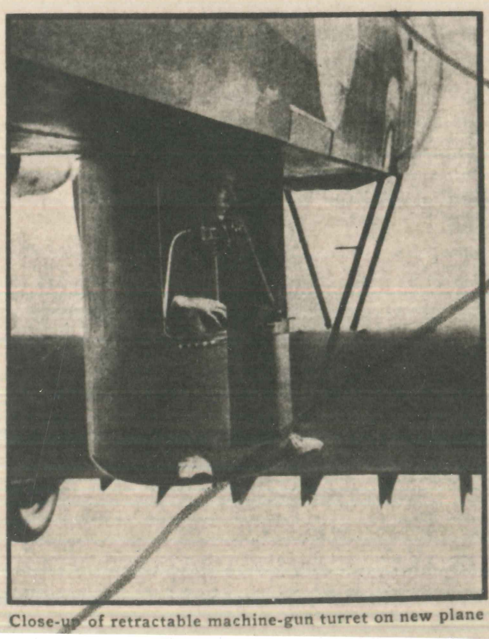
Diagram shows how an automatic record is made of changing air pressure at various points on exterior of a plane during a flight. Note tiny orifices in rudder that admit air which affects flexible diaphragm



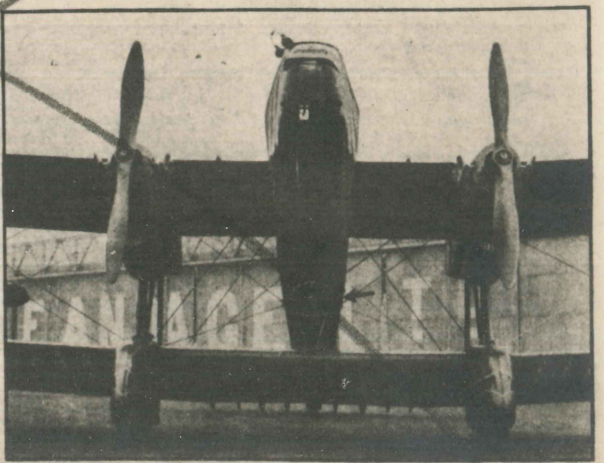
How speed of modern aircraft has been increased by cowling, fillets, and proper placing of propeller with regard to the wing is made clear in this diagram. Use of fillets has raised speed twenty miles an hour

New War Plane Has Movable Gun Turret

OFFICIALLY known as an express bomber, England's latest 150-mile-an-hour war plane has been nicknamed the "flying ash can." It takes its name from the cylindrical turret that can be dropped below the fuselage during flight. Protected within the turret, a machine gunner can pour a deadly stream of fire upon hostile aircraft attacking from the rear. When no longer needed, the turret is pulled back into the fuselage to reduce wind resistance. The big bomber is powered with two 525-horsepower motors, and has a cruising range of nearly 1,000 miles without refueling. Despite its ponderous appearance, it can rise to an altitude of nearly two miles above the earth, affording an important advantage in wartime maneuvering.



Close-up of retractable machine-gun turret on new plane



Front view of new plane. Dotted line shows location of gun turret

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All of us here are vitally affected by progress in airplane design. Most of us are professionally concerned with it; but all of us, whether professionally concerned or not, are affected, and so are our 130,000,000 fellow-countrymen. We, and they, are affected as taxpayers, and as travelers, and as users of the mail service, and as citizens concerned with the nation's welfare and the nation's economic progress and the nation's safety.

Some of our fellow-countrymen share with the similarly uniformed in other lands some grave delusions on the fashion in which progress in design is made. They suppose it to be the productof the unpredicdable working of inventive talent, the outcrop of sporadically scattered veins of invention that show themselves in revolutionary innovations sprung full-blown from the inventor's brow.

We know better. And in knowing better, from our own observation of how the new takes gradual form to supplant the old, we do not belittle but magnify the role of individual genius. We recognize it in its true place. It is the compass of progress, but it is not the power-plant. Individual imagination, or ingenuity, or inspiration if you like, tempered by the study of the preceding art and whetted to a fine edge by the free working of many individual talent upon one another, selects the direction in which progress may best be sought. But the actual propulsion of effort in the chosen direction until the goal is reached requires something more than individual gifts. It demands organization, and equipment, and funds with which to work, and a consistent policy. We are met here today to record another triumph of organization, another

This is a True Copy
Dorothy C. Pyle
Dorothy C. Pyle
2nd Lt. AC.
Assistant Historical Officer FAF

expression of long-continued policy, the completion of another piece of equipment.

To say that progress is dependent on research is to repeat the obvious. Not merely is it within the personal knowledge of every person here, but it is true by definition. Research represents the systemctic quest of knowledge. The progress in the mechanical arts that is made without being either preceded or immediately accompanied by some addition to knowledge of the sciences that underlie the mechanical expression is exceptional indeed. The knowledge that comes without seeking, by happy chance rather than by systematic quest, is almost equally unusual. Occasionally, fortuitous circumstances presents itself to the eager and inquiring mind and eye, and shrewd interpretation adds to the store of human wisdom. Occasionally, the two wires casually crossed to convey a current stick together when the time comes to separate them, the incident falls under the eye of the right observer, and electric welding is started on its way. But for every occasion on which favorable chance plays a part in producing incidental knowledge, there are hundreds in which the increase of knowledge, and the subsequent improvement of the useful arts, are the product of determined and organized investigation.

The term "research" is a broad one, covering many matters. Research may at times be prosecuted with no tools other that a

Pencil and a pad of paper; but it is the general rule that as the mechanical arts are developed to progressively greater refinements, the tools needed for effective research work become more elaborate and more extensive. It is the general rule, too, that as the stores of knowledge continue to accumulate it becomes ever more necessary to bind the underlying science close to the application. Cut-and-try methods alone are superseded, and the man who started with a pad and a pencil and the man who started on the principle of trying everything and seeing what would work find themselves drawn closer together until finally they are joined in a common effort, no longer slightly contemptuous rivals but merged into a common personality.

Though the occasion of our meeting here is aeronautical, I cannot resist dwelling a moment upon the fact that these tendencies are general. Physical research was once the domain of a man with a kit of tools. The contrast between what seemed to the Curies or to Rowland an adequate laboratory and the modern installation of cyclotrons and their atom-splitting like represents the passage from one world to another. In the time when a good many of us were making our first acquaintance with the physical sciences as undergraduates, their etical and experimental physics were treated as subjects almost apart. Who now shall draw the line between them, and where will he put it?

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In aeronautics, the increasing specialization and elaboration of research arrangements have taken forms with which we are all familiar. We are all familiar, too, with the increasingly close integration of mathematical and experimental work, and with the need in effective research of organizations representative of many talents.

In the early days, of almost pastoral simplicity, aeronautical research meant a wind tunnel, and a wind tunnel meant a piece of apparatus so simple as to be well within the financial means of any technical school. Not only did nothing of larger capacity then exist; no particular urge for larger capacity was felt. Our tests on wings and on models of complete airplanes were run on 18 inch models at speeds of 30 miles an hour or thereabouts, and testing at two or three different speeds below that maximum gave a curve that we extended smoothly to infinty, with and indication of an almost uniform correction factor for scale plane parts upsetting our confidence in so magnificent an extrapolation, as sudden irregularities now and then appeared in curves that were otherwise smooth. As thicker wings began to be used, irregularities became more and more frequent. The reputation of the wind tunnel as a sure guide to aeronautical progress was shaken; scale effect began to be a major preoccupation in connection with aerodynamic studies; and designers began to speak of the desirability of making wind tunnel tests under full scale conditions, with the deprecatory manner of men who know that they are asking for the moon and who haven't the slightest expectation of getting it.

Nevertheless they got it. Within the past twenty years that dream of the impossible has become substantially accomplished fact, and those of you who have been regular attendants at the Langley Field conferences of the last dozen years have had the record of its realization unrolled before your eyes, page after page of it.

It is twenty years this spring since the N.A.C.A started its work at Langley Field. There was one building then; it still stands, but now as one of the most modest among many. When the first N.A.C.A. wind tunnel was laid out we recognized three problems of difference between laboratory and full-scale conditions. First was that of Reynolds Number, which had by that time been raised to some 300,000 in the wind tunnel, as compared with the 60,000 of the pre-war years, but still left a 20-to-1 gap between the wind tunnel values and the highest encountered in flight. Second there was the problem of building the model, for in modelling complete airplanes we regretfully recognized the utter impracticability of making a literal scale reproduction of every part, and the neccessity of guessing at the total effect of all the model's omissions. Third, difficulties were already being encountered with propeller tip speeds in a range where compressibility was becoming important, and we met

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those speeds with practically no resources except the largely emperical data of ballisticians.

There seemed little enough prospect at that time of a real remedy for any of those defects. It seemed likely enough that experimenters in aerodynamics would continue to approximate and extrapolate, and that for realy refinement of determination of the effect of changes in design we should still have to depend on flight tests, with all thier shortcomings and experimental difficulties. Yet within a few years a mingling of brilliantly original concept and of immense boldness of plan, backed b y resources such as only a governmentally sponsored organization was likely to possess for such a purpose, had made a direct attack on each of the major problems. Dr. Munk proposed the introduction into speed-scale effect of the third element of pressure, as a means of raising Reynolds' Number within the compass of the laboratory, and without unduly increasing the forces that the model must bear. The National Advisory Committee saw the immense possibilities, and received the funds from Congress to give the idea its first practical embodiment. The variable-density tunnel raised the Reynolds' Number, almost at a stroke, from less that 500,000 to a full 3,000,000 or more than half the highest values then commonly encountered in flight operation.

Almost the same time, the Committee was laying plans for the first wind tunnel which would solve the problem of accurate reproduction of detail in a model, and also that of relationship between the airplane and its power-plant; for it was to be the first in which a full-sized fuselage could be set up with its regular engine installed and running. The propeller research tunnel went into operation in 1927, and through the door that it opened Mr. Weick and Mr. Wood and their associates here at Langley Field advanced with swift directness to the NACA cowl and its revolutionary consequences in design.

Restlessness is the characteristic of competence in technical development. The success of the propeller research tunnel of 20-foot diameter spurred ambition to go still farther, accommodating not only the fuselage and its power-plant but the entire airplane. The full-scale tunnel resulted, and a long succession of airplanes of up to 50-foot span have now been poised, complete in every part, upon its balances. Trails of changes in detail of form that once would have needed preparatory days in the shop, followed by hours of flight testing that would have given an uncertain result at best where only small differences were involved, have now become the subject of a far more accurate determination within a few hours' time. At the same time that the problem of making a model genuinely representative of a

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full-sized airplane was being solved by letting the airplane replace the model, the new tunnel was further increasing the highest attainable Reynolds' Number 8,000,000.

The third problem had been that of speed, and whereas it had once appeared only through its effect on the tips of propeller blades it began, before the end of the "twenties, to assume importance in the level speed of racing airplanes, and in the diving of military machines. The Advisory Commitee turned next in that direction. It was again at Langley Field, and in 1934 that for the first time in more than 25 years a wind tunnel of more than 18 inches diameter, and therefore able to take reasonably complete models of substantial parts of an airplane's form, was first operated at a speed higher than any aircraft had ever reached up to that time. Prior to 1934, the fastest airplanes, had paced the fastest wind tunnels, again excluding some work done by the Army Air Corps, and elsewhere with tunnels of very small dimensions. Since 1934, the relationship has been reversed, and the fastest wind tunnels have paced the fastest airplanes.

Once the road of wind-tunnel development was a stright and smooth one. Each new tunnel might be a little larger and have a speed a little higher than its predecessor, but all wind tunnels served very much the same purposes. The road has long since forked and spread out into many paths, as wind tunnels have become more and more specialized. A very large proportion of those paths have first been explored at Langley Field and those and others that have been taken up have been developed and enlarged upon and given improved applications here. The gust tunnel, the

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smoke tunnel, the icing tunnel, the spinning tunnel, and the free-flight tunnel, together with the types already mentioned, all of them represent a high development of their kind,many of them the highest yet know, some of the the only examples existent.

But are and science will not stand still, and no one is so surely doomed to disappointment as the man who whishes to wait for technology to "stabilize" itself by coming to rest. Where once it seemed simple enough to extend the curves of aerodynamic coefficients from a Reynolds' Number of 60,000 on to infinity, we now feel far more uncertain about the properiety of such extension even from Numbers of 8,000,000 or more. The airplane increases in size and speed, and the Reynolds' Numbers of flight, which seldom exceeded 8,000,000 at the end of the war, are now up to 25,000,000 or higher. As we learn more of the importance of boundary-layer structure, we acquire also a growing respect for the effect of Reynolds' Number even in the highest ranges. The influence of the surface condition of a wing upon the performance of an airplane, for example, can hardly be projected with assurance from one Reynolds' Number to a very different one, even though the smaller of the two beyond any value of which we ventured to dream ten years ago. Hence the work that we are celebrating today.

The first variable-density wind tunnel was built at Langley Field in 1923; the first tunnel of really large size in 1927.

Today we see the two features combined, supplementing one another in reaching out for a Reynold's Number that will exceed 20,000,000 Rapid as is the progress of the airplane, the wind tunnel is catching up. Several years ago, the wind tunnels at Langley Field surpassed the fastest airplane in speed; now they are on the point of equalling the largest of airplanes in effective scale, after taking account of the effegts of pressure.

The new pressure tunnel, like its various predecessors, goes into service with an impressive list of firsts to its credit. It is particularly striking that it is the first in which the operators, like caisson workers driving a tunnel, will themselves by under pressure, leaving their working quarters through a decompression chamber. The air will pass through the test chamber at approximately 250 miles an hour, and in a stream 19 feet in diameter Apropeller 34½ feet in diameter will drive the air; 8,000 electrical horsepower will drive the propeller.

This dedicatory ceremony is in two parts. You have already seen the other half of its occasion, - seen it in action. Five years ago a free-flight wind-tunnel was in the category of the things of which we talked in mellow mood in the boat going back to Washington after a day at Langley had stimulated the imagination, and we prefaced our remarks with the hypothetical introduction: "Wouldn't it be wonderful if they could - - - -?" Two years ago we saw the first model, set up on a modest scale to study the idea. Now it comes full-fledged, ready for work, promising to bring flying qualities down to earth as other wind tunnels have brought down performance. Here too the tunnel works under pressure, reducing scale effects and allowing models of heavier and hence of simpler construction than would otherwise be possible. The model files freely in a 12-foot stream, as we have already seen; the whole installation contained within a 6--foot sphere.

What next? Where do we go from here? I will not estimate how many new types of wind tunnel practical need may henceforth suggest and ingenuity devise, but the present types will increase their scope. No insuperable barrier blocks the way to still larger sizes and still higher speeds. The cost mounts high,-- the power consumpton attains staggering figures, -- but the wind-tunnel method retains its place. For a great volume of work it is the only method. For a great deal more it is the most accurate and the quickest and the safest and, everything considered, the most economical. It is not easy to put a monetary value upon the 10 percent of increase in the speed of a military airplane that a few days of study in the full-scale wind-tunnel have been known to effect, nor can a dollar figure easily be assigned to the improvement in stability and control that means increase of safety. But some idea of the direct economic benefit comes with the reminder that an increase of just 1 percent in the crusing speed of all the transport airplanes used on American air routes, gained by the aerodynamic refinement to which wind tunnels are directed, would save $200,000 a year in operating costs, with a corresponding benefit for the users of the service and for the taxpayer who contributes the air mail compensation.

Volume of work, even more than further increase of capacity, is the problem of the hour. All over the world, the pace quickens. The problems of basic research, in aerodynamics and in structural theory and in the functioning of power-plants, growmore pressing as the intimacy of design's dependence upon them becomes more apparent. Every new type of airplane presents a research problem of itsown, or a series of them, in the analysis and perfection of its aerodynamic details. As production orders grow larger, and as schedules are tightened to reduce the interval from completion of the first model to release of production drawings to the shop, the consequences of doing less well than the best that might have been possible grow more serious. Every new model that has to be given its final rating, or to go to production, without a thorough analysis in a wind- tunnel of fully adequate capacity, because the existing facilities were overloaded and the airplane could not wait, is a lost opportunith. I believe that there has never been one of these meetings at Langley Field at which the visitors failed to present, as urgently needing attention, enough proposals for research to keep the entire establishment and its entire staff working at capacity for two years or more. That ratio of demand for research to the capacity for performing it is higher now than ever before.

The future is always uncertain; never more so than now; but one thing is eternally true. It was true a thousand years ago; it will be true a thousand years hence; it is true now. Organized research was and is and will be the leader of technical progress; the facilities of research must be adequate to the problem; the greater the concentration of effort on research, the more rapid and the steadier the advance that can be expected; the amount of research that is justified will be in proportion to the scope and significance of the art in which progress is sought.

Dr. E. P. Werner's address, Dedication of 19 ft. Pressure and 12 ft.
Free Flight wind tunnels,
May 2, 1939

REC'D 18 1940

THE FOUNDATIONS OF AIR PROGRES

by John F. Victory
For National Aeronautic Magazine
January, 1940.

Aviation progress is achieved seemingly as an exception to the natural laws governing increases in speed in other forms of transportation. The major vehicles of powered transportation are steamships, trains, automobiles and airplanes. The normal method to increase speed is to provide additional power. For example, the present top speed of a large ocean liner is about 36 miles per hour, which requires an enormous power plant. To increase its speed 10 miles per hour would require about twice the power plant. This would reduce its pay load, increase its cost of construction and operation, and make it economically impracticable. To increase the speed of trains and automobiles requires not only better roadbeds and highways as prerequisites to safe operation but also involves an increasing rate of expenditure of power for each mile-per-hour increase in speed.

This is not necessarily so in the case of the airplane. Why? Because scientific research in aeronautics is constantly providing new means of materially reducing the drag or resistance of the airplane, and large increases of speed are thus made possible without the need for additional power. Of course, the speed of an airplane can be increased by providing additional power, but the great protion of speed increases are not achieved in this way. For example, to increase the speed of a 200-mile-per-hour airplane to 250 miles per hour, merely by adding power, would require approximately 100 per cent increase in power. If this were the only method used to increase airplane speed from the time of the Wright Brothers' first flight, the airplane which holds the world's present speed record of 469 miles per hour would have required 22,000 horse power instead of 2,000 horse power which it actually had. To give a clear-cut example: A few years ago the Army standard bomber was the Keystone biplane which, with 950 horse power, was rated at 126 miles per hour. Its immediate successor was the Martin bomber which, incorporating at the time the latest results of scientific research and with an increase of only 200 horse power, flew nearly 100 miles per hour faster.

So much by way of introduction to the fact that

THE FOUNDATIONS OF AIR PROGRESS.

Scientific research underlies and accelerates air progress. The scientific data contained in the reports of the National Advisory Committee for Aeronautics (N.A.C.A.) serve as an indispensable basis for the design of new and improved aircraft by the manufacturing companies. Comprising the N.A.C.A. are 16 men of recognized ability appointed by the President and serving without compensation. Technical subcommittees recommend programs for aeronautical research which are conducted under the supervision of the main Committee.

Airplane performance, efficiency, and safety today are outstanding examples of the fact that the relatively new science of aeronautics is progressing upon a strong foundation of organized scientific research. The results of aeronautical research are used by designers and development engineers to produce aircraft of ever-increasing performance and reliability.

That the United States has been able to hold a place in the forefront of progressive nations in the progress of aeronautics is due largely to a fundamentally sound policy of the President and of the Congress in providing liberal and continuous support of the research activities of the N.A.C.A. Since its establishment by law in 1915, the N.A.C.A. has developed an aeronautical research laboratory at Langley Field, Virginia, which has pioneered in the development of special research equipment on a major scale to meet the research needs of aviation, military and civil.

The new type of wind tunnels first designed by the N.A.C.A. have inspired other nations to copy and improve upon them, and to build larger research laboratories. It is only through research that any great nation can protect its investment in air defense, for unless its aircraft can match those of an enemy not only its investment but a war involving its national existence may be lost. When it comes to a show-down the most costly holding is a second-best hand in a poker game.

Before describing the laboratories in which the N.A.C.A. attacks the fundamental problems of flight let us consider some of the problems. The primary problem on an airplane is, of course, the means for sustaining it in the air. This is done by a device that transfers the weight of the airplane to the air, so that the air exerts an upward force on the airplane which, in level flight is just equal to the weight of the airplane. The wings of an airplane will cause this if they travel through the air fast enough, or the rotating wings of some aircraft will do this if they are turned fast enough. Wings as well as all other bodies passing through the air encounter resistance and this must be overcome by the propelling means. The propulsion system adds to the weight that must be supported by the air and any increase in this decreases the useful load that may be carried by the aircraft.

Many problems of research arise from just these general considerations, as, for example: to improve the shapes of wings so that they will support greater loads with less resistance; to decrease the resistance of all other parts of the airplane; to make the weight of the propulsion system a minimum for each unit of power delivered; and to make the structure as light as possible and yet strong enough to withstand all the loads to which it will be subjected.

Fortunately for aeronautics, the forces acting on an airplane in flight can be reproduced on the ground by blowing air over the airplane. By using scientific methods and instruments it is possible to predict what the forces on an airplane in flight will probably be from tests of the airplane, or of an accurate model of the airplane, in a wind tunnel. The wind tunnel, first used by the Wright Brothers, has become an indispensable tool of the aeronautical researcher and is an unusual piece of apparatus. The N.A.C.A. wind tunnels are especially noted for their unusual characteristics.

The first N.A.C.A. wind tunnel of unusual character was the variable-density tunnel, (completed 1922) designed to provide results more truly representative of conditions on full-size airplanes in flight than had previously been obtainable in small-size tunnels operating at normal air pressure. The tunnel (see Fig.) is enclosed within a steel tank, in which air is compressed up to as much as 20 times its normal density, or to about 300 pounds per square inch. When a model 1/20 the size of the airplane is tested in this tunnel there flows over the wings of the model the same mass of air per second as would flow over the wings of the full-size airplane in flight. Thus flight conditions are more accurately duplicated and the results are correspondingly more accurate. Wing shapes developed in this tunnel have materially increased the speed, range, and carrying capacity of American airplanes. For years, this wind tunnel was unique, but several foreign countries now have tunnels of this type.

The next piece of large-scale research equipment constructed by the N.A.C.A. was the 20-foot wind tunnel (1925) for investigating full-size propellers and the main parts of a full-size airplane. In this wind tunnel the N.A.C.A. cowling for radial air-cooled engines was evolved. This plane speed upwards of 15 per cent. In view of the widespread use of radial air-cooled engines today, the savings in gasoline alone from this one product of research would more than equal in a single year the cost of all the research equipment now standing at Langley Field. Following this work, investigations in the 20-foot tunnel revealed that an engine nacelle with cowling was most efficient when located directly ahead of the wing rather than above or below, which was the former practice. This research had a revolutionary effect on airplane design and performance, both military and commercial. Used in conjunction with the N.A.C.A. wing filletting research results, it permitted of such increases in speed as to justify the use of the retractable landing gear. The simultaneous use of this combination of factors added about 90 miles an hour to airplane speeds and made possible the long-range modern transports and bombers.

Encouraged by the success of the 20-foot wind tunnel, the N.A.C.A. next constructed its full-scale wind tunnel 1931 in which a small full-size airplane complete with engine and propeller can be tested. An idea of the size of this wind tunnel may be gained from the photograph which shows an actual airplane mounted on the balance. The air jet of the tunnel is 30 feet high and 60 feet wide. After an airplane has been designed incorporating fundamental data furnished by previous research in smaller wind tunnels, the air forces acting on the complete airplane are measured in this wind tunnel and the results are analyzed with a view to increasing further the efficiency of the complete airplane. By such investigations on prototype airplanes, the top speeds even after good designing have been increased by as much as 50 miles per hour.

A still more recent piece of equipment, the 8-foot high-speed wind tunnel, placed in operation in 1936, makes available air speeds in excess of 500 miles per hour in its test section. Data from this wind tunnel have shown the changes of shape necessary to maintain efficiency at high speeds, and also the strength and stiffness of wings necessary to avoid wing flutter and to maintain safety at high speeds. This tunnel also provided data showing the importance of having smooth wings. For example, it was shown that on a typical projected large air transport (3600 sq. ft. 250 M.P.H.), the drag of rivet heads and lopped joints was such as to require over 600 horsepower to pull the rivet heads through the air. Interpreted into dollars and cents, this would mean an extra expenditure for gasoline alone of approximately $18,000 a year for each such airplane in regular service. Making the wings smooth, as recommended, would eliminate this expense.

In addition to the wind tunnels, the National Advisory Committee for Aeronautics maintains a flight research laboratory, an engine research laboratory, and a hydrodynamics laboratory at Langley Field. These laboratories, together with those previously described in more detail, are all working under high pressure to meet the research needs of American aviation including those of the Army, the Navy, and the Civil Aeronautics Authority.

The results of investigations in these laboratories that are not Government secrets are published in the form of N.A.C.A. Technical Reports which can be procured at a nominal cost from the Government Printing Office, Washington, D. C. The Reports are also supplied to institutions of higher education for the information and use of students of aeronautical engineering and serve to keep technical workers up to date in this rapidly-growing field.

With the farsighted support of the Congress in making provision at the present time for a large expansion of the Government's aeronautical research activities, the National Advisory Committee for Aeronautics is now expanding its laboratories at Langley Field in addition to equipping a complete new laboratory at Moffett Field in California. This new expansion will enable the Committee to follow even broader lines of research than those that have yielded such valuable results in the past.

12/19/39

BOMBING AIRCRAFT SINK THE FRANKFURT

All-Day Day Attack Off Virginia Capes Brought to Successful Conclusion by Army Planes

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EARLY HITS INEFFECTIVE

But Lawson's Martin Bombers Finish the Job 10 Minutes After Undertaking it.

THREE BOMBS DO THE TRICK

Two Hit Cruiser's Deck and Third, Exploding Alongside, Breaks Her Back.

Special to the New York Times

ON BOARD U.S. DESTROYER LEARY, AT SEA, EN ROUTE TO NORFOLK, July 18. - Brig. Gen. William Mitchell supported his contention respecting the ability of bombing aircraft to deal with capital and other types of naval vessels late this afternoon when a squadron of army bombers from Langley Field sank the ex-German cruiser Frankfurt by aerial bomb attack at sea sixty miles east of the Virginia Capes.

After a series of bombing attacks by navy, army and Marine Corps flyers which lasted all day the army brought the operations to a sensational finish when a squadron of its bombers so wrecked the Frankfurt with three bombs that she was battered and sinking within ten minutes after they began their attack.

The bombs which did the work weighed 600 pounds each and were loaded with powerful charges of T.N.T. The attack was divided into two phases, during the first of which six attacks were made by army, navy and Marine Corps planes which used lighter bombs, weighing from 250 to 300 pounds each. The assault of these lighter bombs lasted from 9:30 o'clock this morning until 1:56 o'clock this afternoon, and after several visits to the target vessel the official board of observers reported that, while severe damage had been done to the deck and upper works of the Frankfurt, the hull seemed intact. No water was entering it, and up to the very edge of the attack by the army and navy Martin bombers, with 600 pound bombs, it was the belief of members of the board that it would be useless to go ahead with the rest of the aircraft attacks. Plans were being made in the assembled fleet for the destruction of the Frankfurt by gunfire attack by destroyers or by time bombs to be placed on board the target ship by wrecking party of the battleship North Dakota.

This is a true copy.
Dorothy C. Pyle
DOROTHY C. PYLE
2d Lt., Air Corps
Asst. Historical Officer, F.A.F.

It was at this juncture, while members of the prospective wrecking party from the North Dakota were being assembled with a view to sending the Frankfurt under the waves by the time bomb route, that the squadron of army Martin bombers, commanded by Captain Lawson, brought the operations to a sensational finish.

Lawson's Army Bombers Come Up

Messages, in fact, had gone forward from the air flagship Shawmut, which carried the official board, directing the army bombers not to come to the target area at sea, ninety-seven miles from army air base at Langley Field, but to await orders before proceeding. This message was sent a little before 3 o'clock, but was countermanded later, and the heavy army Martin bombers in Captain Lawson's squadron were permitted to proceed.

The Seventh Division of three navy Martin, carrying bombs weighing 520 pounds each had just dropped ten of them and scored two hits at 3 o'clock without putting the Frankfurt in a sinking condition. At that hour Captain Lawson's squadron of six Martin bombers, loaded with the 600-pound bombs was en route from Langley Field to sea, and the [illegible] of battleships, destroyers, and naval vessels, their decks lined with officers and thousands of enlisted men in white uniform, was waiting for the next move in the game.

Between [illegible] and 3:30 o'clock the air flagship Shawmut seemingly lost half an hour after the big navy Martins completed the attack without sinking the Frankfurt. Then the Shawmut drew alongside the Frankfurt, and almost simultaneously Captain Lawson's army bombers were sighted sixty miles outside the Capes.

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2,000-POUND BOMBS FROM ARMY PLANES SINK OSTFRIESLAND

"The Bombs That Sank Her Will Be Heard Round the World," Says General Williams.

IS BATTLESHIP OBSOLETE?

Observers Answer No, but New Means of Protection Must Be Created.

TWO BOMBS DID THE WORK.

Dropped in the Sea Near the Ship. They Opened Her Seams and Sank Her in 25 Minutes.

Special to The New York Times.

ON BOARD U. S. DESTROYER LEARY, at Sea, en route to Norfolk. July 21. - The problem of whether the modern battleship can be sunk by aircraft bombing attack was solved in double quick time this afternoon when army Martin bombers attacked at sea sixty miles outside the Virginia Cape and sank the ex-German dreadnought Ostfriesland, with 2,000 pound demolition bombs in twenty-five minutes.

Only one division of six Martin bombers and one Handley-Paige plane made the attack, each carrying and dropping a "powerful 2,000 pound TNT bomb, but the Ostfriesland had been disposed of and was under the surface of the ocean when the Handley-Paige machine, carrying the seventh and last bomb, attacked and dropped its bomb as a parting funeral salute to what was once the pride of the Germany navy.

"Will Be Heard Round the World."

General Williams, army Chief of Ordnance, sounded the keynote of comment in which groups of officers, aircraft men and other experts indulged after the bombing. General Williams said:

"I don't think that the modern battleship has been shelved or rendered obsolete by the sinking of the Ostfriesland. A bomb was fired today that will be heard around the world. It is a heavier explosive charge than has ever been delivered against a battleship. Its sinking of the Ostfriesland means that the capital ship now faces a new menace that must be guarded against by every possible study and effort.

This is a true copy.
Dorothy C. Pyle
DOROTHY C. PYLE
2d Lt., Air Corps
Asst. Historical Officer, F.A.F.

"The biggest mine exploded against battleships weighs 500 pounds; the biggest torpedo, 500 pounds; the heaviest depth charge, 300 pounds, and the biggest charge ever fired from a big gun was 1,800 pounds, fired from the big Gathman experimental gun. Today we have seen a 2,000-pound bomb, halfof whose weight represented TNT explosive, dropped alongside a battleship after having been carried by an airplane 100 miles from base out to sea. The thing done today was the carrying of a mine of unprecedented size out that distance in land planes and putting it down successfully. Stop and think of what that all means."

Air Commodore Charlton of the British Navy did not care to comment at length on the results, but echoed General William's view by saying:

"My only comment is that this shot will ring around the world. That's been said before, but it's true."

Vindicates General Mitchell.

Until today the consensus of opinion among naval officers on the transport Henderson, witnessing the test as experts, was that the Ostfriesland would not be sunk by the airmen, and that it would be necessary otbatter [SIC] the target to pieces with broadside salvos of the 14-inch guns of the flagship Pennsylvania of the Atlantic fleet. The apparent failure yesterday of smaller bombs of 230,550 and 600 pound weight to destroy the watertight integrity of the turret encourages naval men in their argument that Brig. Gen. William S. Mitchell, Assistant Chief of the Army Air Service was wrong in his belief that aircraft would destroy the Ostfriesland, much less put her "out of action."

Tonight General Mitchell is a hero in [illegible] [illegible] establishments of tidewater Virginia, idolized by members of the air brigade at Langley Field, while officers of the navy doff their caps to him as a man who has "made good."

GRADUATES

THE AIR CORPS TACTICAL SCHOOL

(From Personnel Files, 1920 - 1931, Base Headquarters, Langley Field, Va.)

1920--1921 Class

Name	Rank
**Milling, T.D.	Maj. AC.
Johnson, Davenport	Maj. AC.
McNarey, Joseph T.	Maj. AC.
Hanley, T.J., Jr.	Maj. AC.
Walton, Leo A.	Maj. AC.
*Knight, Louis R.	Capt. AC.
*Lawson, Walter R.	Capt. AC.
*Reynolds, Clearton H.	Capt. AC.
Easterbrook, Arthur E.	Capt. AC.
Bissell, Clayton	Capt. AC.
Blackburn, Thomas W.	Capt. AC.

1921--1922 Class

Name	Rank
** Brooks, Arthur R.	Capt. AC
Brower, Gerald E.	Maj. AC.
Colgan, John G.	Maj. AC.
** Drayton, Harry C.	Capt. AC
* Hale, Frasier	Capt. AC
Heisen, Horace N.	Capt. AC.
Hough, Romeyn B.	Capt. AC.
House, Edwin J.	Capt. AC.
Parks, Victor, Jr.	Maj. CWS
Phillips, Chas. T.	Maj. AC.
* Sturcken, Harold E.	Capt. AC.
Voss, Thomas S.	Capt. AC.

This is a true copy.
Dorothy C. Pyle
DOROTHY C. PYLE
2d Lt., Air Corps
Asst. Historical Officer, F.A.F.

* - Deceased
** - Retired
*** - Resigned

1922--1923 Class

Name	Rank
Clagett, Henry B.	Lt. Col. AC.
McChord, Wm. C.	Lt. Col. AC.
**Coker, Robert	Major, AC.
***Jouett, John H.	Major, AC.
Houghland, Howard J.	Major, AC.
Beam, Rosenham	Major, AC.
Jacobs, Lynwood B.	Major, AC.
Hopkins, Hubert V.	Major, AC.
Guildera, Albert M.	Capt. AC.
Hill, Edmund W.	Capt. AC.
Brady, Francis M.	Capt. AC
Gates, Warner B.	Capt. AC.
Warren, George S.	Capt. AC.
Johnson, George P.	Capt. AC.
Wheeler, Chilian F.	Capt. AC.
Hunter, Frank O'D.	Capt. AC.
Ford, Christopher W.	Capt. AC.

1923--1924 Class

Name	Rank
**Graham, Harry	Lt. Col. AC.
Sneed, Albert L.	Lt. Col. AC.
Reynolds, John N.	Lt. Col. AC.
Harms, Henry W.	Major, AC.
Brooks, John B.	Major, AC.
Lyon, Edwin B.	Major, AC.
Wooten, Ralph H.	Capt. AC.
Lynd, Wm. E.	Major, AC.
Davies, Isaiah	Capt. AC.
Grisham, James L.	Capt. AC.
*Austin, Charles B.	1st Lt. AC.
Davies, John H.	Capt. AC.
Burrows, Paul E.	Capt. AC.
Hardee, David L.	Capt. Inf.

1924--1925 Class

Name	Rank
Fisher, Arthur G.	Colonel, AC.
Pickel, Jacob E.	Lt. Col. AC.
Chaney, James E.	Lt. Col. AC.
Martin, Frederick L.	Lt. Col. AC.
Frank, Walter H.	Lt. Col. AC

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1924--1925 Class (cont'd)

Name	Rank
Tinker, Clarence L.	Major, AC.
Van Nostrand, Percy E.	Major, AC.
*Duty, William B.	Major, AC.
Spatz, Carl	Major, AC.
*Benedict, Charles C.	Major, AC.
*Whiteside, John G.	Major, AC.
**Boland, Thomas	Capt. AC.
Quinn, Orlo H.	Capt. AC.
Seaton, David S.	Capt. AC.

1925--1926 Class

*Lutz, Charles A.	Major, USMC.
*Geiger, Harold	Major, AC.
*Hickam, Horace M.	Colonel, AC.
**Heffernen, Leo G.	Major, AC.
Knerr, Hugh J.	Major, AC.
Coleman, Fred H.	Major, AC.
Davis, Michael F.	Major, AC.
Sartorious, Carlos	Capt. Spanish Army
Bourne, Louis M., Jr.	Capt. AC.
Harvey, Lloyd L.	Capt. AC.
Farthing, Wm. E.	Capt. AC.
Duncan, E.E.W.	Capt. AC.
Kenney, G.C.	Capt. AC.
Rogers, F.O.	1st Lt., USMC
Streett, St.Clair	Capt. AC.
*Motley, L.W.	1st Lt., AC.

1926--1927 Class

Turner, T.C.	Lt. Col. USMC
Westover, O.	Lt. Col. AC.
Goolrick, R.E.M.	Lt. Col. AC.
Akin, S.B.	Major, SC.
Rader, Ira A.	Major, AC.
Lohman, E.A.	Major, AC.
Bradley, Follette	Major, AC.
Armstrong, F.T.	Major, FA.
Royce, Ralph	Major, AC.
Reel, Gordon	Major, Air Res.

1926--1927 Class

Name	**Rank**
Haines, Oliver	Maj. Cav.
Candee, R.C.	Major, AC.
Epling, F.G.	Capt. AC.
**Bubb, C.B.B.	Capt. AC.
**Chester, E.W.	Capt. Inf.
Mitchell, Ralph J.	Capt. USMC
Svasti, V.L.	1st Lt., Siamese AS
Sinhaseni, M.	1st Lt., Siamese AS
Stenseth, Martinus	Capt. AC.
Farrell, Walter G.	Capt. USMC

1927--1928 Class

Andrews, F.M.	Lt. Col. AC.
Arneman, C.E.	Maj. FA.
Brett, G. H.	Lt. Col. AC.
**Brown, R.S.	Major, AC.
Cunningham, C.H.	Major, C.E.
Curry, John F.	Lt. Col. AC.
Jones, J.W.	Major, AC.
Krostad, A.N.	Lt. Col., AC.
Morales, Oscar	Maj. Guatemalan Army
Richards, H.H.C.	Major, AC.
Scanlon, M.F.	Major, AC.
Walsh, R.L.	Major, AC.
Evans, F.T.	Major, USMC
Blatt, R.C.	Capt. Cav.
Ballard, R.H.	Capt. AC.
Cutler, S.	Capt. Inf.
Davis, J.E.	Capt. USMC
Hale, W.H.	Major, AC.
Mulcahy, F.P.	Capt. USMC
Olds, Robert	Capt. AC.
Phillips, T.R.	Capt. CAC.
Stone, L.F.	Major, AC
Wise, W.W.	Capt. CWS
Bonnet, E.	Lt. Argentine N.

1929--1930 Class

*Amara, Luang	Lt. Col., Siamese
Deves, Luang	Major, Siamese
Fitz, Harold G.	Major, FA.
Lewis, John E.	Major, FA.

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1929--1930 Class (cont'd)

Metzger, Earl H.	Maj. CA.
Miller, J. F.	Maj. AC.
Moore, J. Merriman	Maj. Inf.
Quesenberry, M. H.	Maj. Inf.
Stratemeyer, Geo. E.	Maj. AC.
Weir, Benjamin G.	Maj. AC.
Yount, Barton K.	Lt. Col. AC.
Bassich, Cyril	Maj. FA.
Black, Percy G.	Maj. FA.
Branson, Harry L.	Capt. Cav.
Eglin, Freerick I.	Maj. AC.
Flickinger, Harrison W.	Capt. AC.
Hoyt, Ross G.	Capt. AC.
Ladd, Arthur K.	Capt. AC.
Major, Harold C.	Capt. USMC

1930--1931 Class

*Cadaval, I.F.J.	1st Lt., Argentine
Strom, Gustaf Q.	Capt. Swedish RAF
Harris, Field	Capt. USMC
Medaris, Lester N.	Capt. USMC
Merritt, Lewie G.	Capt. MC.
Andrews, Wm. V.	Capt. AC.
Beaton,Harold W.	Capt. AC.
Breene, Robt. G.	Capt. AC.
Chauncey, Chas. C.	Capt. AC.
Chennault, Claire L.	Capt. AC.
Collar, Gilbert T.	Capt. AC.
Cousins, Ralph P.	Maj. AC.
Edwards, Idwal H.	Capt. AC.
Eubank, Eugene L.	Capt. AC.
Fitzgerald, Shepler W.	Maj. AC.
Gravely, Wm. S.	Capt. AC.
Larson, Westside T.	Capt. AC.
McDonald, Geo. C.	Capt. AC.
McHenry, Geo. A.	Capt. AC.
McKiernan, Wm. Jr., Jr.	Capt. AC.
Miller, Lester T.	Capt. AC.
Moon, Odas	Capt. AC.
Oldfield, Chas. B.	Maj. AC.
Pursely, Chas. A.	Capt. AC.
Reed, Walter J.	Capt. AC.
Wheeler, Walter J.	Capt. AC.
Whitehead, Ennis C.	Capt. AC.

1930--1931 Class(cont'd)

Name	Rank
Wilson, Donald	Maj. AC.
Young, Harry H.	Maj. AC.
Jones, Wm. H., Jr.	Maj. Inf.
Browns, Harrison C.	Lt. Col. Inf.
Glessner, Hamilton H.T.	Capt. Signal Corps
**Harrington, Arthur S.	Maj. FA.
Boone, Abbott	Lt. Col. FA.
Hyde, James F. C.	Capt. Eng. Corps
Herman, Harrison	Maj. Cav.
Flint, Harry A.	Maj. Cav.